WOODHOUSE EXHIBIT 4

EXHIBIT Q

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA

RICHARD KADREY, an individual, et al. v. META PLATFORMS, INC., a Delaware corporation; Defendant.	Case No. 3:23-cv-03417-VC

REBUTTAL EXPERT REPORT OF BARBARA FREDERIKSEN-CROSS
Signed in Hubbard, Oregon on February 10, 2025

Barbara Frederiksen-Cross

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I. ASSIGNMENT

1. I have been retained by counsel for Meta Platforms Inc. ("Meta") to provide expert analysis in the matter *Kadrey et al v. Meta Platforms Inc.*, Case Number: 3:23-cv-03417-VC. I have been asked to prepare an expert report in response to aspects of the Opening Expert Report of Jonathan Krein, dated January 10, 2025 ("Krein Report") regarding the BitTorrent protocol, and allegations that Meta "seeded" Plaintiffs' works.

2. I am informed by counsel that, in order to show infringement of their copyrighted works, Plaintiffs must show that they own a valid copyright in their books and that Meta copied protectable elements of those books. I am further informed by counsel that Plaintiffs bear the burden of proving that Meta infringed their copyrights. I am further informed that, in connection with the use of the BitTorrent protocol, Plaintiffs allege that Meta distributed Plaintiffs' works to third parties by "seeding" those works.

3. The opinions in this report are based on my research and experience in the field of computer software and computer networking, specifically the BitTorrent protocol and clients such as "libtorrent," as well as the materials I reviewed in preparation of this report which are listed in **Appendix D**. Support for the development of this report was provided by Keystone Strategy LLC, and by my colleagues at JurisLogic, working under my direction and supervision. The opinions expressed here are mine alone.

II. QUALIFICATIONS

4. I am the Director of Litigation Services for JurisLogic, LLC ("JurisLogic"). JurisLogic is an Oregon corporation that provides consulting services to computer hardware and software manufacturers and computer-related technical assistance to the legal profession in the United States, Canada, Japan, China, Europe, and the UAE. My experience includes software design, programming, project management, capacity planning, performance tuning, problem diagnosis, and administration of hardware, operating systems, application software, and database management systems. I have over fifty years of personal experience as a software developer and consultant, including the analysis of computer-based data, software development of web-based systems, and software development for secure online data systems used by banks, insurance companies, hospitals, and telecommunication providers.

5. I have experience in the design, development, and analysis of computer software, and I have previously provided both trial and deposition testimony as an expert for matters in federal and state courts, authored a number of papers, and delivered lectures on technology to the legal profession. My curriculum vitae is attached as **Appendix E** to this report and lists the publications I have authored in the last 10 years and the cases in which I have testified by deposition or at trial in the last 4 years.[1]

6. I also have prior experience with the analysis of peer-to-peer ("P2P") file distribution networks, including both the analysis of BitTorrent-related source code and testing related to BitTorrent's operation. This experience includes tests in which I created torrent files, used BitTorrent to upload and download files, used BitTorrent to transfer files over computer networks, and captured and analyzed BitTorrent network traffic. I have also studied both publicly available BitTorrent source code (including libtorrent[2] and other implementations), as well as source code for proprietary file distribution software that uses the BitTorrent protocol, and proprietary systems used to monitor BitTorrent activity.

7. My background and experience also include the design, implementation, and ongoing administration of databases and multi-dimensional data aggregation systems, including data extraction, transfer, and load operations used for data analysis platforms. My experience also includes programming for embedded and robotic systems. I also have experience with computer and network capacity management, storage management, and disaster recovery planning and testing.

8. I have previously qualified as an expert in federal and state courts to testify about the operation of computer software and computer systems, including for matters that involve software development disputes, failed software systems, and patent, copyright and trade secret disputes. I have also previously testified as an expert in several litigation matters that involved BitTorrent technologies. My work in these other matters included analysis and testimony

[1] **Appendix E**, Curriculum Vitae of B. Frederiksen.

[2] "Libtorrent," libtorrent, accessed February 5, 2025, https://www.libtorrent.org/.

relating to systems that monitor P2P file distribution systems and send notices to Internet Service Providers ("ISPs") based on the activity they detect.

9. I am a member of the Institute of Electrical and Electronics Engineers ("IEEE") and the Association for Computing Machinery ("ACM").

10. I am a salaried employee of JurisLogic, which specializes in providing consulting services to corporations and attorneys on intellectual property matters (such as copyright and patent infringement matters, and misappropriation of trade secrets) and performing assessments of computer software, large scale computer data productions, software-controlled devices, and software development projects. I am also one of the principals of JurisLogic. JurisLogic is compensated at the rate of $595 an hour for my work in this case. My compensation as a principal of JurisLogic, and any compensation that JurisLogic receives from my services on this case, does not in any way depend on the substance of my opinions or the outcome of this or any other case.

11. If called upon to testify at trial, I may present oral testimony and/or tutorials about the operation of BitTorrent, the evidence I analyzed, my analysis processes, and the opinions I formed based on my analysis.

12. In addition, I understand that I may testify regarding my opinions on related matters, including those raised at trial by Plaintiffs' attorneys and experts, or the Court, concerning these issues. I reserve the right to supplement my report in the event that new facts become known to me before trial that impact my opinions or the bases therefor and to respond to responses to my opinions. I am aware of the continuing obligation to supplement my report under Rule 26 of the Federal Rules of Civil Procedure.

III. SUMMARY OF OPINIONS

13. In this report, I respond to several assertions the Krein Report makes regarding Meta's use of "BitTorrent," the alleged "seeding" of data, and Meta's environment for performing torrent downloads. Based on my analysis, I demonstrate that the Krein Report (i) misunderstands and mischaracterizes the BitTorrent protocol when suggesting that Meta seeded data, (ii) does not consider the safeguards implemented by Meta to prevent the seeding of downloaded data, nor

the myriad of unlikely factors that would have needed to occur for seeding to take place, and (iii) presents no evidence that Plaintiffs' (or any) works were actually seeded by Meta, and rather only speculates that this was the case based on the existence of torrenting scripts in Meta's codebase.

14. First, based on its static and isolated analysis of Meta's source code files,[3] the Krein Report presents conjecture on the possibility of additional datasets potentially torrented by Meta. In **Section V.B** below, I present evidence that the Krein Report misstates the datasets torrented by Meta.

15. Then, in its description of the "BitTorrent" protocol, the Krein Report misrepresents fundamental concepts of the protocol in claiming that Meta necessarily seeded the at-issue data. The Krein Report inaccurately asserts that (i) "[a]ny computer using a BitTorrent client/library application becomes a host for any data they download," (ii) "[t]his reciprocal condition of hosting is called "seeding," and (iii) "when Meta torrented LibGen, the LibGen data was seeded back out to other peers in the network.""[4] This description mischaracterizes the core components of the BitTorrent protocol as employed by Meta, ignores the safeguards implemented by Meta to prevent data seeding, and ignores the confluence of several technical factors that would have needed to occur for Meta to have seeded Plaintiffs' works to others on the BitTorrent network. As I describe below, these ignored factors make it highly unlikely that Meta seeded Plaintiffs' works.

16. With respect to seeding (which refers to the ability of a peer on the BitTorrent, after the download of the torrented data is complete, to share the data with other peers on the network),[5] as I discuss in **Section IV.B**, Meta had safeguards built in that prevent seeding such as (i) removing the torrent from the session within no more than 60 seconds after the torrent download has completed, and (ii) blocking all unsolicited inbound connections, effectively rejecting requests from un-connected leechers during the maximum 60 second period.

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[3] Krein Report ¶¶127, 168.

[4] Krein Report ¶¶118, 127.

[5] Krein Report ¶119; See also: BitTorrent Limited, "Help Center - What Is Seeding?," BitTorrent, accessed February 8, 2025, https://www.bittorrent.com/en/support/solutions/articles/29000041669-what-is-seeding-.

17. Further, in order for Meta to have seeded Plaintiffs' works, many different practical and technical factors would have had to come together that, in my opinion, make it highly unlikely that this could have occurred. Specifically, **all** of the following must have been true:

    a. Meta must have initiated the connection with the particular leecher in question. As I discuss in **Section VI.C.1**, Meta's network configurations would have blocked any connections not initiated by Meta,

    b. The leecher must not already have possessed the particular pieces of the torrent containing Plaintiffs' works. If the leecher already possesses these pieces then it will not require them from Meta,

    c. The leecher must have prioritized the pieces containing Plaintiffs' works (which represent small portions of the datasets downloaded using BitTorrent). If the pieces are not prioritized, Meta's code may remove the torrent (within the maximum of 60 seconds), before the pieces can be seeded to the leecher,

    d. The leecher must have randomly selected Meta as the seeder among available peers from which these specific pieces are to be obtained. The leecher would be equally likely to receive the pieces containing the Plaintiffs' works from any of the other randomly selected peers that had those pieces,

    e. The leecher must have been able to receive the pieces from Meta before the torrent was removed from the session (within a maximum of 60 seconds),

    f. Finally, a leecher must have remained in Meta's unchoked slots long enough to download a piece containing Plaintiffs' works.

18. I note that the Krein Report does not point to any evidence that any one of these preconditions to seeding Plaintiffs' works was present, much less all of them. Nor does the Krein Report show that Meta actually seeded any data, let alone any of Plaintiffs' works, and any suggestion that this occurred is pure conjecture.

19. In sum, based on the safeguards implemented by Meta, the numerous factors in the torrent network that would have needed to align, and the de minimus proportion of Plaintiffs' works to the at-issue datasets (as discussed in **Section VI.C.2**), it is highly unlikely that Meta seeded the Plaintiffs' works to other peers.

20. I begin with a description of the requisite technologies involved in downloading files over the internet and specifically using the BitTorrent protocol in the following section.

IV. BACKGROUND ON BITTORRENT AND TORRENTS

21. The Krein Report asserts that "Meta directly downloaded at least one copy of LibGen and torrented at least one copy of LibGen via BitTorrent methods,"[6] further stating that certain datasets were "seeded."[7] To respond to these assertions, it is first necessary to provide a background and understanding of the different technologies that underlie the torrenting process. In the following section, I first describe the basic components involved in accessing files over networks, followed by a description of peer-to-peer networking. Then, in **Section IV.B** below, I detail the BitTorrent protocol and introduce key terms. In **Section IV.C,** I discuss the process of downloading a file using the BitTorrent process. Finally, in **Section IV.D** I outline a few contemporary uses of the protocol.

22. The cornerstone of modern computing is the ability to access information almost instantaneously. The advent of technologies enabling such access began out of the need to efficiently access information among scientists and governments spread across the world. First designed to overcome this problem, ***computer networks*** are a set of interconnected computers with the ability to communicate information via wired or wireless methods.[8] The ***internet*** is composed of multiple networks that are all interconnected to facilitate the efficient flow of information.[9]

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[6] The Krein Report, ¶28.

[7] The Krein Report, §§ 9.3.4, 10.2.4.

[8] "What Is Computer Networking? | IBM," July 1, 2024, https://www.ibm.com/think/topics/networking.

[9] Computer Networking: A Top-Down Approach, p. 28.

23. To communicate via the internet, computers utilize standardized ***protocols*** that represent a set of rules and instructions that determine how information is transmitted between different entities.[10] For instance, on the internet, computers utilize the ***Internet Protocol*** (IP) to send data, assembled in a standardized format that can be understood by both the sender and the recipient of the data.[11] As another example, most websites are accessed using the ***Hypertext Transfer Protocol*** (HTTP),[12] which was initially designed and commonly used in the 1990s for communicating between a ***web browser*** and a ***web server***,[13] but has evolved to be used in many applications such as machine-to-machine communication or programmatic access to other programs.[14] A web browser is a software program that enables users to view and interact with content by interacting with a web server, which is a computer that possesses the requisite content on the internet.

24. The web browser relies on a ***Uniform Resource Locater*** (URL) that points to a specific resource on the internet and is itself comprised of various parts such as the data needed to identify (i) protocol used for communication, (ii) a ***domain name*** which is the name of the website requested to be accessed by the user,[15] and (iii) a ***path*** within the domain that would contain the required information or service.[16] In practice, a user wishing to access content over the internet utilizes a web browser and inputs a URL, which instructs the browser to locate the content on a web server and access the requisite information or service. In the next section, I further explain the technical nuances that underlie the process of accessing large files over the internet.

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[10] Computer Networking: A Top-Down Approach, p. 35.

[11] Computer Networking: A Top-Down Approach, p. 31.

[12] Computer Networking: A Top-Down Approach, p. 129.

[13] Computer Networking: A Top-Down Approach, p. 130.

[14] A popular implementation is in the form of Application Programming Interface (API) that run on top of HTTP to exchange information between multiple applications. See: Computer Networking: A Top-Down Approach, p. 468.

[15] As discussed below, the domain name is further converted into a unique identifier for a server where the information would be accessible, using a Domain Name System (DNS). See: Computer Networking: A Top-Down Approach, p. 160.

[16] Computer Networking: A Top-Down Approach, p. 129-130.

A. Basics of Accessing Files over the Internet

25. As explained above, the internet allows for and facilitates access to information over interconnected computer networks, communicated from a computer containing the requisite information to another computer requesting it. In this section, I outline the processes involved in accessing files and data over the internet, as well as different protocols that enable this flow of information. I also introduce peer-to-peer networks, which present unique advantages for utilizing the resources available on the network.

26. For every network, there is a finite speed that data that can be transmitted from one location to the other; this is referred to as the ***bandwidth*** of the network.[17] More specifically, the bandwidth of a network is defined by the maximum amount of data that can be transmitted in a given time (usually measured in bits[18] per second (bps)).

27. Bandwidth is a fundamental constraint imposed on the network due to physical limitations of the network infrastructure like cables, routers, and wireless frequencies used.[19] Over time, advancements in networking technologies, such as use of fiber optic cables in place of copper cables,[20] have significantly increased data transfer rates. Still, inherent limitations in bandwidth necessitate careful consideration to ensure data is transmitted reliably and efficiently.

28. An advancement in networking that revolutionized the methods of transmitting data with limited bandwidth in the 1960s, was that of ***packet-switching***.[21] With packet switching, any information transmitted over a vast network is first broken down into small units of data,

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[17] "Network Bandwidth: What Is Bandwidth in Networking? - IT Glossary | SolarWinds," accessed February 5, 2025, https://www.solarwinds.com/resources/it-glossary/network-bandwidth.

[18] A bit is the smallest unit of data that can be processed by computers, represented by one of two values: 1 or 0. See: "Definition of Binary Digit (Bit) - Gartner Information Technology Glossary," Gartner, accessed February 5, 2025, https://www.gartner.com/en/information-technology/glossary/bit-binary-digit.

[19] "What Is Network Bandwidth and How Is It Measured?," Search Networking, accessed February 5, 2025, https://www.techtarget.com/searchnetworking/definition/bandwidth.

[20] Charter Communications, "Why Is the Bandwidth of Optical Fiber High? | Spectrum Enterprise," accessed February 5, 2025, https://enterprise.spectrum.com/content/spectrum/enterprise/en/home/support/faq/internet/why-is-the-bandwidth-of-optical-fiber-high.html.

[21] "Packet Switching," ETHW, February 17, 2024, https://ethw.org/Packet_Switching.

referred to as ***packets***.[22] Each individual packet is then sent over the network from the sender's computer to the recipient's computers using ***routers***, which analyze the packet's destination address and decide the best path to forward it such that it is ultimately received by the appropriate recipient.[23,24] Thus, the path from the sender to the recipient for a packet is determined dynamically, allowing for packets to take alternative paths to reach the recipient over a network, instead of following a pre-determined path.[25] In this way, packet-switched networks alleviate some concerns around limited bandwidth by breaking larger data transmissions into smaller pieces of information, and choosing the best network to transmit them so as to avoid congestion due to limited bandwidth.

29. As discussed, the Internet Protocol (IP) is used to transmit each packet to its destination. However, in addition to IP, another related protocol is used in conjunction to ensure that the information is received accurately, i.e., in the proper order and error-free. This protocol is referred to as the ***Transmission Control Protocol*** (TCP).[26] Together, the TCP/IP protocol suite is the foundation of many interactions over the internet, encompassing multiple layers and protocols that enable communication and data exchange.[27]

30. Packet switched networks were devised as a way to ensure reliability of communication sent over physical networks, which is evident given that packet switching provided a way to communicate information even in case of damaged or unreliable communication links along a given path. The utilization of packet switching has enabled a host of improvements for sending large amounts of data over a network, including reliability of communication, efficiency of transmission, and scalability of the network. The same concept of breaking large amounts of data into smaller units to boost reliability, efficiency, and scalability of the network is also

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[22] Computer Networking: A Top-Down Approach, p. 50.

[23] "What Is a Router? | Router Definition," accessed February 5, 2025, https://www.cloudflare.com/learning/network-layer/what-is-a-router/.

[24] Computer Networking: A Top-Down Approach, p. 53.

[25] Computer Networking: A Top-Down Approach, p. 358.

[26] Computer Networking: A Top-Down Approach, p. 31.

[27] Computer Networking: A Top-Down Approach, p. 31.

applied to peer-to-peer (P2P) networks such as BitTorrent as I explain further in the **Section IV.A.3** below.

1) IP Addresses

31. Today, access to the internet is provided by ***Internet Service Providers*** (ISPs), organizations that manage the wired and wireless connections that power computer networks.[28] ISPs build and maintain a vast network infrastructure, including routers and fiber optic cables, which in turn form the backbone of the internet. In addition to the critical role of providing the necessary infrastructure, ISPs also facilitate the registration of domain names, and the assignment of unique addresses for each computer connected to the internet otherwise known as ***IP addresses***.[29]

32. An IP address is a series of numbers that act as unique identifiers for the computer connecting to the internet and its location on the internet, at a point in time.[30] IP addresses are assigned to all ***host*** computers that are connected to the internet as well as web servers. For instance, an IP address for a host on the network is of the format "203.0.113.10", wherein "203.0.113" is a network identifier for the network the host is connected to, while "10" is the identifier of the host itself.[31]

33. Consider the act of sending a physical letter from California to another individual who resides in New York. The IP address is equivalent to the street address of the individual down to the house number, street, city and state that directs the mailing service to the correct recipient address where the letter will be delivered.[32] Similarly, the ISP that handles the host's IP

[28] Computer Networking: A Top-Down Approach, p. 30.

[29] Computer Networking: A Top-Down Approach, p. 120.

[30] A domain name is usually represented by human understandable text, which in turn is translated into an IP address using a ***Domain Name System (DNS)***. See: Computer Networking: A Top-Down Approach, p. 160.

[31] Computer Networking: A Top-Down Approach, p. 160.

[32] One nuance to note here is that the IP address assigned by an ISP to a host can be determined dynamically (i.e., the IP address assigned to a host changes periodically based on availability and efficiency of the network) or can be static, meaning that the IP address for the host stays fixed and does not change over time.

address assignment is able to associate the IP address to a specific device connected to the internet.[33]

34. In practice, when a computer connects to the internet, the ISP assigns an IP address to the host. Then, as the user inputs a URL in a web browser, the domain name component is also translated into an IP address using a ***Domain Name System*** (DNS).[34] In this way, the web browser accurately identifies the address of the appropriate web server from which to request the required files. IP packets carrying a web request include the IP address of the user's device as the source address and the IP address of the web server as the destination address. The server then sends response packets containing the requested content (such as a webpage) back to the user by using the original source address as the destination. As a result, the IP address plays a key role in directing the required content to the appropriate computer, and back, without any confusion.

2) File Transfer, File Transfer Protocols, and Ports

35. The term ***downloading*** generally refers to a process by which a computer receives data from another computer, often a remote computer over a network. For example, when a computer requests and then receives a file from another computer on the internet, this is often referred to as downloading the file. ***Uploading*** refers to the opposite process, by which the computer transmits data to another computer such as a remote computer over a network. For example, if that same computer sends a file to another computer over the internet (such as in response to a request from the other computer), this is an example of uploading that file.

36. As discussed above, the TCP/IP protocol is the foundation on which data is transferred over the internet. However, specialized protocols are also developed on top of the TCP/IP protocol based on specific requirements of the data. For example, the HTTP protocol was initially designed specifically for transmitting hypertext files. Another common protocol, designed specifically for sharing files over the internet is the ***File Transfer Protocol*** (FTP).[35]

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[33] In most cases, an external IP address is associated with a router that is used to connect the devices on a home or business network to the Internet.

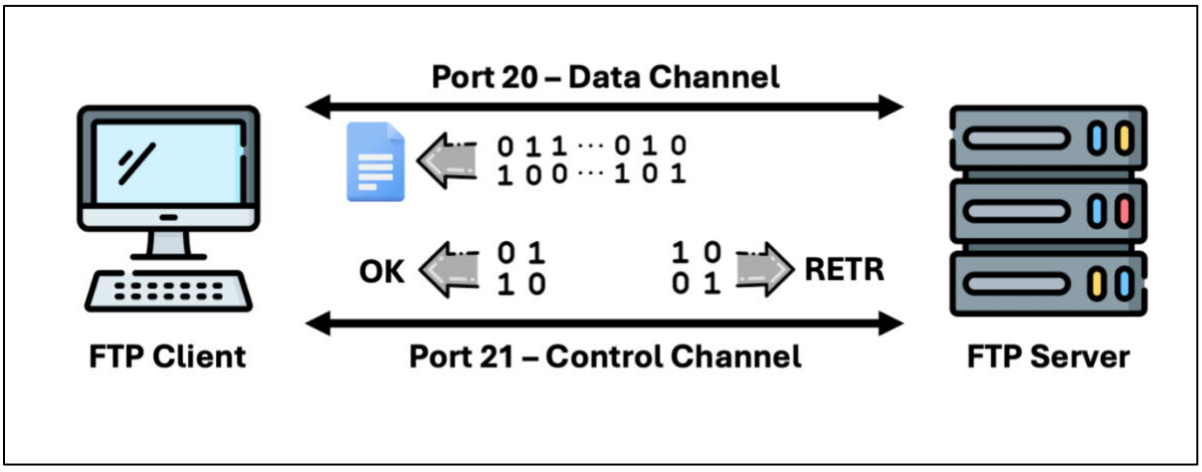
[34] Computer Networking: A Top-Down Approach, p. 161.

[35] Computer Networking: A Top-Down Approach, p. 116.

37. A majority of the interaction for data on the internet flows through a ***client-server model***, in which the interaction for accessing files is between (a) the client requesting data for download and (b) a centralized server that contains the requested data.[36] In this model, a user looking for particular information is the ***client*** and accesses the information from some centralized server or system, such as YouTube (for a cooking video), Amazon (for information about products), or Wikipedia (for an article from its large online encyclopedia).

38. Within the client-server model, protocols such as FTP enables a client requesting data to interact with the server containing the information by opening two channels of communication: control and data channels. Both these channels in turn connect with different ***ports*** on the server, which are the standardized endpoints for programs running on the server.[37] The ports enable a distinct flow of control information to be sent simultaneously but separately from a distinct flow of data between the same client and server. For instance, the control channel in FTP connects to port 21 on the FTP server, whereas the data channel connects to port 20, as shown below.[38]

Figure 1 - File Transfer Protocol Retrieve Process



39. The control channel communicates requests to the server such as "RETR" for retrieving a file from the server, or "STOR" for uploading a file to the server. In turn, the server responds with

[36] Computer Networking: A Top-Down Approach, p. 115-116.

[37] Computer Networking: A Top-Down Approach, p. 120-121.

[38] "WinZip | Download Your Free Trial," accessed February 5, 2025, https://www.winzip.com/.

the status of the file (e.g., if the file exists on the server) as well as requests for any additional information required from the client (e.g., password for accessing the file), on the control channel. The control channel is thus responsible for establishing, maintaining, and terminating the session between the client and the server.[39] On the other hand, the data channel is responsible for the actual transfer of file contents that have been broken down into small units and sent in data packets.[40] The compilation of all packets when received by the client results in the downloading of the file from the server on the internet.

40. Modern web browsers rely on HTTP or the more secure HTTPS protocols for downloading files.[41] Similar to FTP, HTTP and HTTPS clients send a "GET" command to the web server in order to download a file.[42] The server then responds with the data packets to port 80 for HTTP and port 443 for HTTPS,[43] which are then compiled and saved on the local machine by the browser. Even though the protocol for accessing the file on the web server differs, the actual data packets are still sent over TCP and IP, as discussed above.

41. All the protocols discussed thus far are based on a client-server model, in which the data to be acquired resides on a central server or system, giving rise to inherent limitations for communication of that data. The primary limitation is the dependency on a central server for delivery of required data files to multiple clients.[44,45] The development and maintenance of such a central server is often a costly undertaking and can lead to diminishing performance as a large number of clients request the same file from the central server, thereby competing for its available resources. When a significant number of clients request the same resource (e.g.,

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[39] "What Is FTP? | Definition from TechTarget," Search Networking, accessed February 5, 2025, https://www.techtarget.com/searchnetworking/definition/File-Transfer-Protocol-FTP.

[40] "What Is FTP? | Definition from TechTarget," Search Networking, accessed February 5, 2025, https://www.techtarget.com/searchnetworking/definition/File-Transfer-Protocol-FTP.

[41] "What Is Downloading?," Search Networking, accessed February 5, 2025, https://www.techtarget.com/searchnetworking/definition/downloading.

[42] "IBM B2B Advanced Communications 1.0.0," March 5, 2021, https://www.ibm.com/docs/en/b2badv-communication/1.0.0?topic=api-download-file.

[43] "What Is a Computer Port? | Ports in Networking," accessed February 5, 2025, https://www.cloudflare.com/learning/network-layer/what-is-a-computer-port/.

[44] Computer Networking: A Top-Down Approach, p. 116.

[45] Computer Networking: A Top-Down Approach, p. 184.

during initial release of limited-edition products), the server can become overloaded, causing slowdowns and failures for some clients.[46] Another drawback of the client-server model is that a central server is responsible for retrieving and transmitting the data, and thus provides a "single point of failure," meaning that if the central server fails the data may become entirely inaccessible to all clients. And relatedly, any communication within the client-server model is restricted by the bandwidth available to the central server, which can result in the transfer of very large files taking a large amount of time, as the packets must be individually transmitted by the central server within the limited bandwidth available to it.

42. A ***peer-to-peer*** network architecture addresses these data transmission issues and is discussed in more detail in the following section.

3) Peer-to-Peer (P2P) Networks

43. A peer-to-peer (P2P) network operates in a similar fashion to the client-server model with one key difference: instead of a centralized server, in a peer-to-peer network generally speaking, every computer in the network can act as both a client and a server.[47] From a networking perspective, all computers within a P2P network are ***peers*** that can request specific information from other peers who possess it, or can provide the required information to other peers that are specifically requesting it.[48] This differs from the client-server model where only the centralized server holds the information that can be transmitted to connected clients. Thus, P2P networks are inherently decentralized networks.

44. Each computer that participates in a P2P network is referred to as a ***node***.[49] Whenever a node participates in a P2P network, it contributes to the overall bandwidth, content, storage, and processing power of the entire network. Typically, each client willing to participate in a P2P network runs dedicated software that, in accordance with the P2P protocol in question, initiates a process that allows the client to participate as a node on the P2P network. Essentially, the

[46] Computer Networking: A Top-Down Approach, p. 184.

[47] Computer Networking: A Top-Down Approach, p. 175-179.

[48] Computer Networking: A Top-Down Approach, p. 175.

[49] A peer is always a node, however a node can be a peer or a server client. See: Computer Networking: A Top-Down Approach, p. 62.

software initiates a virtual layer that runs on top of the existing network and is facilitated by the peers that are already participating in the network.[50] It is important to note however that the virtual network operates in much the same way as a physical network, with the key difference being that resources available on the network are contributed by the available nodes already participating in the peered virtual network. For instance, the information transfer between different nodes is still facilitated using a protocol such as TCP or UDP,[51] much like the client-server model,[52] but with an overlay of a P2P-specific communication protocol that defines how data exchanged between the peers is structured, exchanged and verified.

45. The bandwidth in a client-server network is restricted by the bandwidth of the central server. In contrast, the nodes in a P2P network act as both clients and servers, so each additional node contributes to the total bandwidth of the network. Similarly, while the web server in a client-server model possesses restricted processing power and is limited by the available computing resources of the individual server computer, in a P2P network each node contributes a portion of its available processing power to the overall network.

46. P2P networks are not a novel form of computer networking. During the 1960s, ARPANET, the first network capable of transmitting messages between two computers and the precursor to the modern internet,[53] was based on a P2P implementation.[54,55] P2P networks were used as the underlying network architecture of Skype (which stands for "Sky Peer to Peer") for voice

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[50] "Azure Virtual Network Peering," November 19, 2024, https://learn.microsoft.com/en-us/azure/virtual-network/virtual-network-peering-overview.

[51] In some cases, the transfer of information may be facilitated by another protocol, "***User Datagram Protocol***" (UDP), another important component of the TCP/IP protocol suite. This protocol functions similarly to TCP, except that UDP is connectionless. Unlike TCP, clients do not need to establish and verify a connection before sending packets when using UDP. See: Computer Networking: A Top-Down Approach, p. 79.

[52] Jeffrey L Eppinger, "TCP Connections for P2P Apps." http://reports-archive.adm.cs.cmu.edu/anon/isri2005/CMU-ISRI-05-104.pdf.

[53] "ARPANET, Internet," LivingInternet (blog), accessed February 5, 2025, https://www.livinginternet.com/i/ii_arpanet.htm.

[54] A Network of Peers: Peer-to-Peer Models Through the History of the Internet - Peer-to-Peer [Book]," accessed February 5, 2025, https://www.oreilly.com/library/view/peer-to-peer/059600110X/ch01.html.

[55] "Steve Crocker Embodies Peer to Peer Architecture (P2P) as One of the Key Concepts of the ARPANET : History of Information," accessed February 5, 2025, https://historyofinformation.com/detail.php?id=878.

calls over the internet.[56,57] Concurrently, P2P networks and the protocols developed to support them (such as BitTorrent) are utilized for varied purposes such as distributing extremely large files over the internet, online gaming,[58] and supporting cryptocurrencies,[59] among other uses. My discussion of BitTorrent below provides more examples of the use of P2P networking in common real-world applications.

47. There are multiple different protocols that can be used to support P2P networking. The BitTorrent protocol is the P2P protocol that is at issue in this matter. Similar to the packet switching technique discussed above, when using the BitTorrent protocol, any large file is first converted to smaller pieces.

48. In practice, when a node using "BitTorrent" requests specific information (e.g. a request for a particular file), multiple peer nodes that have that information and are participating in the BitTorrent network may respond by providing a portion of the requested file. Since the pieces of the file may be collected from multiple nodes participating in the BitTorrent network (as opposed to a central server responding with all the relevant packets in the client-server model), the BitTorrent protocol can offer advantages with respect to both the availability of a particular file and also the overall speed and resiliency of the network. This is because unlike a client-server model, file distribution is not reliant on a single point of failure or any single bandwidth bottleneck. The entire network benefits by the number of peers that are connected on the network, as well as the number of peers that contain any specific information requested by a user.[60]

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[56] "A Brief History of Skype - the Peer to Peer Messaging Service," accessed February 5, 2025, https://content.dsp.co.uk/history-of-skype.

[57] Salman A. Baset and Henning Schulzrinne, "An Analysis of the Skype Peer-to-Peer Internet Telephony Protocol" (arXiv, December 5, 2004), https://doi.org/10.48550/arXiv.cs/0412017.

[58] "Peer-to-Peer Gaming," Medium, September 22, 2023, https://medium.com/tashi-gg/peer-to-peer-gaming-9991600c6707.

[59] "P2P Network — Bitcoin," accessed February 5, 2025, https://developer.bitcoin.org/devguide/p2p_network.html.

[60] Computer Networking: A Top-Down Approach, p. 178.

B. BitTorrent

49. Like HTTP discussed in **Section IV.A.2** above, BitTorrent is a communication protocol. BitTorrent protocol is used for P2P networks and allows nodes to communicate with one another as peers. Like the FTP communication protocol discussed above, the BitTorrent protocol is specialized to enable transfer of large files over the internet, specifically within P2P networks. As discussed below, based on unique characteristics and techniques used within the BitTorrent protocol, it can be efficient for the transfer of very large files over the internet, and thus, is used regularly in applications requiring downloading of large files.[61]

50. As discussed, an advantage of exchanging files over P2P networks is the increased efficiency afforded by the breakup of large files into small ***pieces*** that are distributed across many nodes participating in the P2P network. Some BitTorrent terminology has multiple context-dependent meanings. For simplicity, this section of my report describes the terms that I will use in this report to refer to different mechanisms within the protocol. Where possible, these are the same terms, with the same meanings, as are used in the Krein report.

51. As discussed in the Krein Report, "[o]nce a peer completed a download of the complete file, it could in turn function as a seed."[62] In line with this definition, I use the term ***seeder*** to describe peers that have completed the download of a file i.e., have a full copy of the original file. In contrast, the term ***leechers*** refers to peers that have begun the download and have no pieces, or that have downloaded only a portion of the complete file.[63] The term ***swarm*** is typically used to describe the collection of seeders and leechers for a particular file or set of files. Once a leecher receives all of the pieces of the complete file, it possesses a complete reassembled instance of the original file(s) and can then be designated a seeder. It is important to note that

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[61] "About BitTorrent | Creator of the World's Leading P2P Protocol," BitTorrent, accessed February 5, 2025, https://www.bittorrent.com/company/about-us/ ("Before BitTorrent, file downloads were initiated from a centralized server or a single user (a peer), resulting in slow download speeds. The BitTorrent protocol addressed this limitation by enabling the download and upload of files between many users. Millions of users began to use the BitTorrent protocol to download and share files, and companies began to use the protocol to distribute data more efficiently. Today, the BitTorrent protocol powers a significant percentage of the world's Internet traffic each day. It isn't just the largest Peer-to-Peer network, it's the foundation of Web3, and one of the Internet's largest global communities. Proof that the technology is more relevant than ever, robust, and now driven by the power of blockchain.").

[62] Krein Report ¶119; See also: BitTorrent Limited, "Help Center - What Is Seeding?," BitTorrent, accessed February 8, 2025, https://www.bittorrent.com/en/support/solutions/articles/29000041669-what-is-seeding-.

[63] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

seeding is an optional process that can commence only after the download of the file has completed. The seeder can choose to stop seeding the data, for example, by not participating in the network once the download is finished.[64]

52. Central to the BitTorrent protocol is a ***torrent file*** (identified by a .torrent extension) which contains key information related to the file that is available on the P2P network. The torrent file does not contain the underlying content to be downloaded; it instead contains the metadata required to reconstruct and validate the payload, including an ordered list of names, and sizes of the files. To avoid ambiguity, I will refer to the underlying content of the target files to be downloaded as the torrent file's ***payload***.[65]

53. Each piece of a complete file that is exchanged over the BitTorrent protocol comprises a portion of some particular torrent file's payload. In addition to identifying the names and sizes of files, the torrent file also contains the ***hash values*** of each piece of the payload that will be downloaded by the client. A hash value is typically computed by a hashing function, which takes the input data and calculates a fixed-length string of characters known as a hash value. Hash values, thus, often serve two purposes in computing. First, hash values allow computers to verify the integrity of data they receive. Second, hash values are often used to uniquely identify data because the underlying hashing function is designed such that each different piece of data should have a different hash value.[66]

54. In BitTorrent, a ***piece hash*** value is derived for the contents of each individual piece of the torrent payload and stored in the torrent file.[67] When a new piece is received, a hash derived from its contents can be compared to the stored piece hash to detect tampering or corruption.

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[64] "After a torrent job finishes downloading, you are highly encouraged to leave the torrent job seeding. Although the length of time that you should leave the file seeding is not defined, it is recommended that you share until the amount of data you upload reaches at least the same as the amount of data that you have download, also known as reaching a 1.0 ratio." See: BitTorrent Limited, "Help Center - What Is Seeding?," BitTorrent, accessed February 8, 2025, https://www.bittorrent.com/en/support/solutions/articles/29000041669-what-is-seeding-.

[65] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[66] It is theoretically possible for hashing functions to generate collisions (*i.e.*, two different pieces of data generate the same hash value), but the possibility of this occurring is infinitesimally small.

[67] This assumes that pieces do not contain exactly the same replicated data.

If there are even slight deviations in the content of the piece that is downloaded, its hash will be different than the expected piece hash.

55. In addition to this piece hash, the torrent file also contains an ***info hash***, which is a hash calculated on all of the file and piece information contained within the torrent file.[68] The info hash is used within the BitTorrent network to identify a specific associated payload and also used by peers in their communications with the tracker, DHT network, and other peers in the swarm.

56. For the BitTorrent protocol, the hash values are calculated using the ***Secure Hash Algorithm - 1*** (SHA-1), a well-known hashing function, and the corresponding hash values are referred to as SHA-1 hashes.[69] As detailed in **Section IV.C.3** below and consistent with the use of hashing functions generally, the hash values are used to verify data integrity for each piece that is exchanged over the BitTorrent protocol, increasing the reliability of file distribution that uses this protocol.

57. Lastly, the torrent file contains the IP address of a ***tracker***.[70,71] A tracker is a server that contains information on the peers that are connected to a P2P network,[72] as well as the status of each peer, i.e., whether the peer has completed the download (i.e., is a seeder), or is still downloading (i.e., is a leecher). The main role of the tracker is for leechers engaged in a download of pieces to find peers that may have the piece that they require. A particular leecher can communicate with the tracker using the HTTP protocol by sending information about what torrent payload it wants to download, causing the tracker to respond with a list of contact information for peers that have that payload.[73] Alternatively, instead of a tracker, peers can

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[68] "Bep_0003.Rst_post," accessed February 5, 2025, https://www.bittorrent.org/beps/bep_0003.html.

[69] "What Is SHA-1 and How Is It Used for Data Verification?" Lifewire, accessed February 5, 2025, https://www.lifewire.com/what-is-sha-1-2626011.

[70] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[71] Torrent files may contain more than one tracker.

[72] Adele Lu Jia and Dah Ming Chiu, "Designs and Evaluation of a Tracker in P2P Networks," in 2008 Eighth International Conference on Peer-to-Peer Computing (2008 Eighth International Conference on Peer-to-Peer Computing (P2P), Aachen, Germany: IEEE, 2008), 227–30, https://doi.org/10.1109/P2P.2008.11.

[73] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

also utilize a ***distributed hash table*** (DHT), which functions as a decentralized way to access information about other peers available on the network.[74]

58. The final piece to understanding the success of the BitTorrent protocol is the choking and unchoking process that enables a leecher to manage its bandwidth and maximize its own download rate. The choke/unchoke algorithm helps a peer maximize its own download rate via the process that selects which peers to "unchoke." On a technical level, this decision is made by each peer by utilizing ***choking algorithms*** that periodically evaluate the peers to connect to. Leechers prioritize unchoking (i.e., allowing the exchange of pieces) from those peers where they can maximize their own download rate.[75]

59. Having described the relevant background for foundational concepts within the BitTorrent protocol, I detail in the next section the process of exchanging files using the BitTorrent protocol, highlighting how these mechanisms together provide an efficient and reliable method for the download and upload of large files over P2P networks.

C. Torrent Process

60. The torrent process is initiated by the client accessing the P2P network using specialized software. The users must first download and install a BitTorrent client on their computer in order to access the BitTorrent P2P networks.[76] While the BitTorrent protocol has a popular client with the same name,[77] i.e., "BitTorrent client," multiple other programs have also been developed that utilize the BitTorrent protocol to interact with peers in the torrent network. Some popular options include, uTorrent,[78] qBittorrent,[79] libtorrent,[80] among others. Since all

[74] Computer Networking: A Top-Down Approach, p. 181.

[75] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[76] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[77] BitTorrent Limited, "BitTorrent Classic | The Original Torrent Client for Desktop," BitTorrent, accessed February 5, 2025, https://www.bittorrent.com/products/win/bittorrent-classic-free/.

[78] BitTorrent Limited, "µTorrent (uTorrent) Classic | The Original Torrent Client," uTorrent, accessed February 5, 2025, https://www.utorrent.com/desktop/.

[79] "qBittorrent Official Website," accessed February 5, 2025, https://www.qbittorrent.org/.

[80] "Libtorrent," libtorrent, accessed February 5, 2025, https://libtorrent.org/index.html.

of these programs communicate using the same BitTorrent protocol, they are able to participate together in the same BitTorrent swarms.

61. The next step is for a user to locate a torrent file for the content they wish to download using BitTorrent. Usually, the torrent file can be located using websites that maintain a list of torrent files or by searching on a search engine web site to locate the desired torrent file.[81] Once the user downloads the torrent file, the torrent file can be opened using the torrent client on the user's computer. Opening a torrent file using a BitTorrent client software results in the creation of a BitTorrent session that allows the user's computer to communicate with other BitTorrent peers who are downloading/uploading the same payload (i.e. the specific payload described by the torrent file).

1) Connection to Peers

62. Within a torrent session, the first action taken by the torrent client is to locate other peers within the network for that particular torrent file. This is where the tracker is utilized to acquire information about other peers in the network who are participating in the same torrent payload. The leecher sends a request to the tracker passing the info hash of the torrent file as well as the port number on which the leecher is expecting to receive the downloads.[82] The tracker responds with a list of randomly selected peers (including their IP addresses and a peer id) within the network who are currently active for the desired info hash payload.[83] Alternatively, leechers can also access information about other peers by utilizing DHTs. When using DHTs, each node in a swarm contains information about a subset of the other nodes in the P2P network, and messages can be passed from node to node to traverse the network and obtain information or files from other nodes in the network. Similar to utilizing a tracker, when a leecher requests to download a specific payload, a request with the info hash for that payload is sent to the DHT network, which then responds with information about peers who are participating in the BitTorrent network for that payload.[84] In this way, by utilizing either a

[81] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[82] "Bep_0003.Rst_post," accessed February 5, 2025, https://www.bittorrent.org/beps/bep_0003.html.

[83] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[84] Ryan McCarthy, "What Is DHT and How Does It Work for BitTorrent?" December 15, 2022, https://www.downloadprivacy.com/how-to-torrent/dht.

tracker or a decentralized DHT system, a leecher is able to identify peers that have the desired payload.

63. Once the leecher receives a list of peers that are participating in a swarm for the desired payload, the next step is to connect with the peers. Each connection is initiated in the form of a protocol-defined handshake between two nodes. Key steps in the handshake include (i) an exchange that confirms both peers are running client software that uses the BitTorrent protocol and participating in a swarm for a specific payload, which is done by transmitting the info hash associated with a particular payload as a part of the initial protocol handshake, and (ii) having the expected peer id, which is checked by validating a peer's reported id against the peer id the tracker provided.[85] If both sides do not send the same info hash value, or a peer id does not match, the peers sever their connection.[86] Next, the peers begin exchanging messages. As a part of this exchange, the peers first identify what pieces of the payload they already have, and later what pieces they are seeking.

2) Downloading Pieces

64. Once connected to other peers via the handshake process described above, a leecher can request different pieces of the payload from multiple peers simultaneously in order to boost the chances of finding peers that can provide the pieces it wants.[87] It does so by sending out piece request messages to peers that have indicated they have pieces that the leecher needs. As the peers respond, the requesting peer can download different pieces from different peers, at the same time.

65. There are further optimizations that are conducted by the BitTorrent protocol at this stage, such as (i) breaking up of pieces into sub-pieces,[88] (ii) sending multiple queued requests for sub-pieces to the peers,[89] as well as (iii) organizing the pieces that are prioritized for download by

[85] "Bep_0003.Rst_post," accessed February 5, 2025, https://www.bittorrent.org/beps/bep_0003.html.

[86] "Bep_0003.Rst_post," accessed February 5, 2025, https://www.bittorrent.org/beps/bep_0003.html.

[87] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[88] Typically of 16KB each. In this report, when I refer to a piece, I only refer to the full piece, instead of the sub-pieces that are created by the BitTorrent client.

[89] Otherwise referred to as TCP pipelining, a process to ensure that the available bandwidth is fully utilized for downloading accessing different sub-pieces.

the leecher.[90] The first and the second optimizations are implemented such that multiple portions of a piece can be received from different peers in parallel, thereby reducing the time to download a given piece. Lastly, the selection and prioritization of the pieces to download is based on the status of the downloaded file. When a download is initiated, a random piece of the file is typically prioritized for download. After the first full piece is downloaded, the BitTorrent protocol may switch to a "rarest-first" piece selection policy. As its name implies, a "rarest-first" policy prioritizes selection for download of the rarest pieces, (*i.e.*, pieces that are available from the fewest number of connected peers). Prioritizing rare pieces over pieces that are more commonly available helps ensure that additional copies of the rare piece become available within the swarm more quickly.[91]

3) Completion of Download

66. Finally, when a piece is received by a peer such that all the sub-pieces for that piece have also been downloaded, a hash check is conducted by comparing the hash calculated from the received piece with the corresponding piece hash provided within the torrent file (which was downloaded at the beginning of the process).[92] If the hashes match, it is verified that the downloaded piece is received as expected, i.e., with the same contents and devoid of any corruption or outside tampering. Once all the sub-pieces and pieces are received, the BitTorrent client effectively consolidates all the constituent pieces into the completed payload.[93] Once the entire payload has been successfully downloaded, the BitTorrent client also reports to the tracker that it has completed the download so that the tracker knows that it is now a seeder.

67. Once the download is fully completed, by default the leecher becomes a seeder.[94] At this point, the seeder can choose to remain a part of the swarm and seed data to other peers. However, this is not a requirement in the protocol and BitTorrent clients, as well as the user, can terminate

[90] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[91] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[92] "Bep_0003.Rst_post," accessed February 5, 2025, https://www.bittorrent.org/beps/bep_0003.html.

[93] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[94] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

seeding once the file is downloaded, terminating the node's connection with the torrent network and thereby preventing the uploading of any pieces to other peers.[95]

68. In the next section, I highlight contemporary uses of the protocol for the exchange of information, by entities such as universities, open-source program distributions, and government organizations.

D. Use Cases of BitTorrent Protocol

69. Since its introduction, BitTorrent has garnered immense support and has become the most popular protocol for peer-to-peer networking.[96,97] Garnering support within the community for exchanging open-source software, i.e., software that is distributed with permissive licenses to be used and developed upon by other users,[98] BitTorrent has been utilized extensively for distribution of the popular Linux operating system.[99] Owing to its open source nature Linux has overtaken the popular Windows operating system across variety of devices such as servers,[100] smartphones,[101] and in-vehicle entertainment systems,[102] all while being distributed by utilizing the BitTorrent protocol.[103]

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[95] BitTorrent Limited, "Help Center - What Is Seeding?," BitTorrent, accessed February 8, 2025, https://www.bittorrent.com/en/support/solutions/articles/29000041669-what-is-seeding-.

[96] Bram Cohen, "Incentives Build Robustness in BitTorrent." https://www.bittorrent.org/bittorrentecon.pdf.

[97] Jahn Arne Johnsen and Lars Erik Karlsen, "Peer-to-Peer Networking with BitTorrent," https://web.cs.ucla.edu/classes/cs217/05BitTorrent.pdf.

[98] "What Is Open Source Software? | IBM," July 29, 2021, https://www.ibm.com/think/topics/open-source.

[99] "If any group has embraced the possibilities and power of BitTorrent for distribution, it is the Linux community. Virtually every distribution is available via torrent download." See: BitTorrent Limited, "Introducing µTorrent Server for Linux," BitTorrent, accessed February 5, 2025, https://www.bittorrent.com/blog/2010/09/02/introducing-µtorrent-server-for-linux.

[100] "Linux or Windows Servers? Which One's Better | Volico," Miami and Broward Colocation | Volico Data Centers (blog), May 20, 2024, https://www.volico.com/linux-or-windows-servers-whats-the-difference-and-whichones-better/.

[101] Android OS runs on a Linux Kernel. See: "Linux or Windows Servers? Which One's Better | Volico," Miami and Broward Colocation | Volico Data Centers (blog), May 20, 2024, https://www.volico.com/linux-or-windows-servers-whats-the-difference-and-whichones-better/.

[102] Robert Huntley, "Linux Gaining Ground in Automotive," EE Times Europe, September 3, 2024, https://www.eetimes.eu/linux-gaining-ground-in-automotive/.

[103] BitTorrent Limited, "Introducing µTorrent Server for Linux," BitTorrent, accessed February 5, 2025, https://www.bittorrent.com/blog/2010/09/02/introducing-µtorrent-server-for-linux.

70. Further, as discussed in **Section IV.B** and **IV.C**, BitTorrent provides an effective and efficient protocol for the transfer of very large files over the internet. BitTorrent is popular among varied institutions such as universities, and governmental and non-governmental organizations. For instance, Florida State University utilized the BitTorrent protocol for distribution of scientific datasets, citing the ability for users to "easily share large data sets using BitTorrent."[104] Additionally, NASA utilized BitTorrent for the distribution of data related to the "visible earth" project for distributing images of Earth for researchers and enthusiasts alike.[105]

71. Owing to its ability to distribute large files quickly, BitTorrent has also been utilized for distribution of security patches, as well as updates to enhance gaming experience for users. For instance, Blizzard Entertainment developers of the popular game "World of Warcraft," utilized BitTorrent for the distribution of patches to the game.[106] World of Warcraft is estimated to have over 160 million players.[107]

72. Since its inception in the early 2000s, BitTorrent has been influential and has been utilized by millions of users for varied purposes including facilitating research, distribution of open-source software, and even promotion of security through distribution of software patches. Examining these diverse use cases provides important context for understanding how BitTorrent operates in practice.

73. Building on this foundation of the BitTorrent protocol and its use cases, the following sections will explain various errors and misstatements in the Krein Report regarding the seeding of data within BitTorrent and the way in which Meta used it to download certain datasets.

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[104]"HPC Data Repository," April 2, 2013,https://web.archive.org/web/20130402200554/https://www.hpc.fsu.edu/index.php?option=com_wrapper&view=wrapper&Itemid=80.

[105] "Nasa Is Using BitTorrent for Their 'Visible Earth'Project * TorrentFreak," accessed February 5, 2025, https://torrentfreak.com/nasa-is-using-BitTorrent-for-their-visible-earthproject/.

[106] Jahn Arne Johnsen and Lars Erik Karlsen, "Peer-to-Peer Networking with BitTorrent," https://web.cs.ucla.edu/classes/cs217/05BitTorrent.pdf.

[107] "Server Population & Player Count," MMO Populations, accessed February 5, 2025, https://mmo-population.com/r/wow.

V. OVERVIEW OF THE RELEVANT SOURCE CODE AND AT-ISSUE DATASETS

74. I have analyzed the two instances in which it has been alleged in the Krein Report that BitTorrent was used by Meta to download datasets claimed to be at issue in this case: (i) in 2023 to download one portion of a dataset known as Library Genesis (LibGen), and (ii) in about April 2024 to download certain datasets from Anna's Archive. In this section, I first respond to the statements in the Krein Report that contain misstatements about the use of source code scripts to perform torrent downloads. I then present the list of datasets actually downloaded by Meta through torrents, demonstrating how the Krein Report inflates the count of the datasets downloaded by Meta using the BitTorrent protocol.

A. The Krein Report Misrepresents Meta's Torrent Source Code

75. The Krein Report discusses the "**download_trnts.py**" code, which based on the evidence I have reviewed, is a Python script that was used by Meta engineer Nikolay Bashlykov in 2023 to download a portion LibGen, and in particular, a portion of that library known as "scimag" that contains scientific articles.[108] As I will explain below in **Section V.B.2**, Plaintiffs' books are not contained in this "scimag" library. There is no evidence that this script was used by Mr. Bashlykov to download any other portions of LibGen or any other dataset, including the fiction subset that Plaintiffs have alleged contains some of their copyrighted works.[109]

76. The evidence indicates, to the contrary, that Mr. Bashlykov used a direct download technique that did not involve the use of the "**download_trnts.py**" script or otherwise use BitTorrent, to download the Fiction and Scitech portions of LibGen. The Krein Report appears to acknowledge as much, stating that the "Meta source code file **download_libgen_direct.py** defines functionality for directly downloading LibGen."[110] It then states: "The file includes a source code comment stating, '`Script to load the libgen library (scitech/fiction) using a direct download link (`***`not torrenting`***`).`'"[111] I have reviewed this source

[108] "Index of /Scimag/Repository_torrent," accessed February 8, 2025, https://libgen.is/scimag/repository_torrent/.

[109] Opening Expert Report of Cristina Videira Lopes, Ph.D., Jan. 10, 2025, ¶¶102, 163 (alleging that LibGen contains 44 at-issue works), 164 (alleging that another LibGen subset contains 34 at-issue works).

[110] Krein Report ¶108.

[111] Krein Report ¶108 (emphasis added).

code script and agree that it does not use the BitTorrent protocol.[112] This is corroborated by other contemporaneous internal Meta documents stating that Mr. Bashlykov used a direct download technique for downloading the scitech and fiction portions of LibGen,[113,114] and which was again confirmed to me during my interview with Mr. Bashlykov.[115] Because these portions of LibGen were not downloaded using torrents, their download could not have created any possibility of upload of that data to other peers via BitTorrent.

77. The Krein Report also acknowledges that the "**download_trnts.py**" script "includes a comment explaining that the script '`downloads scimag using torrent files.`'"[116] The Krein Report does not cite any evidence that the "**download_trnts.py**" script was ever used to download any other portion of LibGen aside from Scimag. It at best speculates that the "**download_trnts.py**" script *could* have been used to download other portions of LibGen but cites no evidence that this ever occurred. Krein acknowledges that the **download_trnts.py** script would have to be modified before it could be used to accomplish his hypothetical downloads. For example, the Krein Report claims that "the **download_trnts.py** script is designed with swappable variables," such that switching the directory from "scimag to, say, scitech or fiction" would have enabled a torrent download of the scitech or fiction libraries.[117] The Krein Report also states that "the source code has been architected for use with not just 'scimag', but also explicitly for use with scitech and fiction as well."[118] But the Krein Report does not present any evidence that any of these hypothetical modifications to the "**download_trnts.py**" script ever occurred. The Krein Report further speculates that the TORRENT_FOLDER variable in the "**download_trnts.py**" script could have been changed

[112] META-KADREY-SC-000197.

[113] Meta_Kadrey_00168648 at Meta_Kadrey_00168656 (entry for 06/16/2023: "LibGen next steps […] probably would need to disclose that we torrented scimag – it wasn't an option to direct-link download it as I did for scitech/fiction, [because] it's very large….").

[114] Meta_Kadrey_00211852 (01/05/2024, 03:15:52 message: "nikolay clarified that it was mostly direct download, only the scimag data was torrented").

[115] Interview with Meta engineer, Nikolay Bashlykov.

[116] Krein Report ¶120 (emphasis added).

[117] Krein Report ¶121.

[118] Krein Report ¶122.

to point to a directory called "`scitech_trnt_files`," or "`fiction_trnt_files`,"[119] but cites no evidence that this ever occurred or that these directories ever existed. Further. Dr. Krein states with no evidence that the DOWNLOAD_DIR variable in the August 2024 "**download_trnts.py"** script "has been set to various paths in the past" even when the March 2024 version he printed also contains no evidence of such past values.

78. I understand that the "**download_spark.py**" script was used in April 2024 to download certain datasets from Anna's Archive.[120] The Krein Report also misrepresents this script, stating "[i]n addition to Meta's documents, its source code also shows LibGen ***fiction*** being torrented from Anna's Archive."[121] The Krein Report claims that because "Meta's script for torrenting from Anna's Archive includes an 'Example command,' which specifies a '`dataset_name`' of '`libgen_rs_fic`,' as well as an '`input_path`' […] and an '`output_dir`'", the mentioned directories are where "LibGen fiction (i.e., '`libgen_rs_fic`') is the data torrented."[122] But as I detail further in **Section V.B** below, the actual files downloaded using this script do not contain LibGen Fiction.[123] I also note here that the "Example command" that Krein cites for this file is present only in the form of comments, not as executable code. In evaluating the text of comments, it is important to understand that they are discretionary annotations that a programmer can record in a script or program. They are not functional code, and they do not control any aspect of the script's actual processing.

79. The Krein Report relies on static and isolated source code, variables, and comments within source code to suggest what datasets were downloaded via torrenting at Meta, often ignoring contemporaneous internal documents. Below, in **Section V.B** I outline the datasets that were downloaded at Meta.

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[119] Krein Report ¶121.

[120] Interview with Meta engineer, Xiaolan Wang.

[121] Krein Report ¶126.

[122] Krein Report ¶126.

[123] Interview with Meta engineer, Xiaolan Wang.

B. The Krein Report Misrepresents the Datasets Downloaded by Meta

80. As I outlined in **Section V.A** above, the Krein Report makes vague assertions regarding the download of datasets at Meta, claiming "Meta's Source Code Includes Scripts to Torrent LibGen,"[124] and "Meta's Source Code Includes Scripts to Torrent Anna's Archive."[125] Below, I discuss which datasets were downloaded at Meta, and narrow the scope of Meta's torrenting to April 2024 because, as noted, the "scimag" portion of LibGen (the only torrents downloaded in 2023) does not contain Plaintiffs' works.

1) Meta Did Not Torrent All of LibGen

81. The Krein Report's claim that "Meta used BitTorrent to download at least one copy of LibGen" [126] is incorrect. As demonstrated in **Section V.A** above, and confirmed by contemporaneous documents,[127,128] as well as the Meta engineer responsible for the torrent download,[129] only the "scimag" library portion of LibGen was downloaded in 2023 at Meta using the BitTorrent protocol. I have analyzed this subset of LibGen in **Section V.B.2** and confirmed that it does not contain Plaintiffs' works. Therefore, the "**download_trnts.py**" script that the Krein Report includes in its discussion of the download of LibGen, and Meta's 2023 torrenting efforts more generally, are not relevant to the at-issue works in this case.

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[124] Krein Report § 9.3.2.

[125] Krein Report § 10.2.2.

[126] Krein Report ¶117.

[127] Meta_Kadrey_00168648 at Meta_Kadrey_00168656 (entry for 06/16/2023: "LibGen next steps […] probably would need to disclose that we torrented scimag – it wasn't an option to direct-link download it as I did for scitech/fiction, [because] it's very large….").

[128] Meta_Kadrey_00211852 (01/05/2024, 03:15:52 message: "nikolay clarified that it was mostly direct download, only the scimag data was torrented").

[129] Interview with Meta engineer, Nikolay Bashlykov.

82. To determine the relevant datasets torrented by Meta in 2024 that could have contained one or more of Plaintiffs' works, I reviewed internal Meta documents and interviewed the Meta engineer responsible for the effort.[130][131] The relevant datasets are listed in **Table 1** below.

Table 1 – Datasets Download by Meta Using BitTorrent

Dataset
Portions of Libgen.rs Non-Fiction "scitech"[132,133]
Internet Archive (IA) [134,135]
Z-Library (ZLib) [136,137]

83. These datasets were indexed by Anna's Archive, a searchable online database that aggregates links to books, academic papers, and other digital content from various other libraries, including LibGen and ZLib. Launched in 2022, Anna's Archive describes its purpose as aiming to provide universal access to knowledge by indexing and preserving sources to access materials.[138] Unlike traditional online libraries, Anna's Archive does not host files itself but instead acts as a meta-search engine, directing users to other sources where they can download

[130] Interview with Meta engineer, Xiaolan Wang; *see also* Meta_Kadrey_00108336 (internal chat conversation listing Internet Archive, Z-Library, portions of LibGen, DuXiu as datasets being downloaded). DuXiu is a dataset containing Chinese language works, and I am not aware of any Chinese language books being among the Plaintiffs' copyrighted works that were allegedly infringed in this case.

[131] Xioalan Wang, a Meta engineer that I interviewed who conducted the 2024 torrent download at Meta created lists of downloaded files, which I reviewed. She created the list by executing a recursive directory command to create a list of files in the AWS storage associated with the download that occurred in 2024.

[132] Interview with Meta engineer, Xiaolan Wang.

[133] meta_nonfic_downloads.txt (This file contains a listing of all LibGen Non-Fiction works Meta downloaded on the AWS instance in 2024).

[134] Interview with Meta engineer, Xiaolan Wang.

[135] meta_ia_downloads.txt (This file contains a listing of all IA works Meta downloaded on the AWS instance in 2024).

[136] Interview with Meta engineer, Xiaolan Wang.

[137] meta_zlib_downloads.txt (This file contains a listing of all ZLib works Meta downloaded on the AWS instance in 2024).

[138] "Frequently Asked Questions (FAQ) - Anna's Archive," accessed February 5, 2025, https://annas-archive.org/faq.

requested materials.[139] Anna's Archive indexes instances of individual books across the datasets that can be sourced from the library. Using its search engine and searching for the book titles and authors provided by the Plaintiffs, I was able to identify all individual torrent files from the LibGen, ZLib, and IA datasets that contain the Plaintiffs' works.

84. LibGen is a digital library that contains millions of books, papers, and textbooks that users can find and download for free.[140] The content is divided by genre, such as fiction, or non-fiction, that is in-turn available to users for downloading content by genre. Following this division, the "Libgen.rs Fiction" dataset mostly contains fictional works such as fictional novels, children's books, etc., the "Libgen.rs Non-Fiction" dataset contains non-fictional works, such as biographies, textbooks, etc., and the "Libgen.rs scimag" dataset contains content from scientific journals, academic papers, etc., as noted. Similar to LibGen, Z-Library ("ZLib") is also a digital library containing millions of books and articles.[141] Finally, Internet Archive ("IA") is a compendium of content available through the internet, since its inception, such as web pages, images, audio recordings, etc.[142] For instance, old versions of a web page may be contained within Internet Archive and can be accessed using the Wayback Machine, which preserves and provides access to archived web pages.[143] The IA data downloaded in this matter also contains books.

2) The Scimag Portion of LibGen Does Not Contain Plaintiffs' Works

85. To verify the contents of the "scimag" portion of the LibGen dataset, I manually searched and retrieved search results from Anna's Archive across all works in all at-issue datasets. I searched for each of the Plaintiffs' works on Anna's Archive, using Anna's Archive search

[139] "Frequently Asked Questions (FAQ) - Anna's Archive," accessed February 5, 2025, https://annas-archive.org/faq.

[140] "Library Genesis," Library Genesis Guide, accessed February 5, 2025, https://librarygenesis.net/.

[141] "About Us | Z-Library. Download Books for Free. Find Books," accessed February 5, 2025, https://z-lib.io/pages/about-us.

[142] "About IA," accessed February 5, 2025, https://archive.org/about/.

[143] "What Is Wayback Machine? | Definition from TechTarget," WhatIs, accessed February 5, 2025, https://www.techtarget.com/whatis/definition/Wayback-Machine.

engine,[144] and extracted URLs and other metadata (such as the MD5 hash[145] of each work, the associated torrent filename, and the associated file size for the Plaintiff work occurrence) for all works that matched. Additionally, I searched for different variations of the Plaintiffs' named works, including those in foreign languages,[146] to ensure I captured the exhaustive list of all occurrences of these works indexed by Anna's Archive.

86. The results of this search confirm that no at-issue Plaintiffs' works exists within "scimag." The name of each torrent file within the "scimag" portion of LibGen is formatted to begin with the "sm_" identifier, indicating that the works that are the payload of that torrent file belong to the scientific articles collection of LibGen.[147] No at-issue Plaintiffs' works are associated with any torrent file that begins with the "sm_" identifier, demonstrating that "scimag" does not contain Plaintiffs' works. This is confirmed through the analysis of the torrent files associated with each occurrence of Plaintiffs' works in the search results, which is described in **Appendix B**.

87. The relevant at-issue datasets that contain Plaintiffs' works downloaded at Meta only include IA, ZLib, and a portion of LibGen Non-Fiction representing Scitech. The "scimag" portion of LibGen is not a relevant at-issue dataset, as it does not contain Plaintiffs' works. Accordingly, the following analysis focuses solely on the confirmed relevant at-issue datasets,

VI. IT IS HIGHLY UNLIKELY THAT META SEEDED PLAINTIFFS' WORKS

88. The Krein Report does not present any evidence that Meta ***actually*** seeded any data, let alone that Meta seeded data comprising Plaintiffs' works. The Krein Report discusses only the ***potential*** for seeding, but this does not demonstrate any ***actual*** seeding.[148] As I demonstrate

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[144] "New Search - Anna's Archive," accessed February 8, 2025, https://annas-archive.org/search.

[145] An MD5 hash is a unique identifier for a book on Anna's Archive. The search results are extracted in the form of "https://annas-archive.org/md5/<MD5 Hash>." Different versions of a book may exist in the same or different datasets downloaded by Meta. For this analysis, I consider all MD5 hashes that are associated with all different versions of the Plaintiffs' works that are accessible through Anna's Archive.

[146] Search results indexed by Anna's Archive contained Plaintiffs' works in languages other than English, including: Chinese, Czech, Dutch, French, German, Italian, Korean, Polish, Portuguese, Russian, Spanish, and Turkish.

[147] "Index of /Scimag/Repository_torrent," accessed February 8, 2025, https://libgen.is/scimag/repository_torrent/.

[148] Krein Report §§ 9.3.4, 10.2.4.

in **Sections VI.C.2** below, Plaintiffs' works constitute a vanishingly small percentage of the downloaded datasets. In light of the evidence that (i) Meta implemented safeguards to inhibit seeding, (ii) only a small proportion of the datasets comprise the Plaintiffs' works, as well as (iii) the large number of events that must match up (as discussed in **Section VI.C.4** below) for the potential seeding of any of the Plaintiffs' works to have occurred, the Krein Report only presents conjecture, without any evidence, to claim that Meta seeded any of the Plaintiffs' works. In my opinion, it is highly unlikely that Meta seeded any of the Plaintiffs' works.

A. Seeding of a Torrent Can Only Occur After the Download of a Torrent is Complete

89. The Krein Report makes several general assertions regarding the BitTorrent protocol using imprecise language, specifically around seeding, and concludes that files downloaded by Meta "become a seed for distribution to other peers in the network" once a given file has been fully downloaded.[149] However, the Krein Report does not acknowledge the fact that seeding is an optional process for a peer that has become a seeder, and only initiated by the BitTorrent client after the download for the entire payload (not just a single file) is **finished**. In this section, I explain the difference between peers and seeders to demonstrate that, due to the safeguards in place to prevent seeding and the many factors that would have needed to occur for seeding, it is extremely unlikely that Meta acted as a seeder for any of the Plaintiffs' works.

90. As discussed in **Section IV.B** and further defined on the BitTorrent website: "Seeding means sharing a file(s) with other peers. After a torrent job finishes downloading, if you leave the torrent job seeding, it uploads the file(s) to other peers so they can enjoy them too."[150] I agree with this definition and note that the Krein Report provides the exact same definition.[151] Conversion of a peer into a seeder, by definition, can only occur after the peer has completed the download of the entire payload. Seeding is an optional process in the BitTorrent protocol, as the source that the Krein Report cites also acknowledges; although many sites related to BitTorrent encourage seeding and consider it to be a social norm or informal rule of etiquette,

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[149] Krein Report ¶¶127, 168.

[150] BitTorrent Limited, "Help Center - What Is Seeding?," BitTorrent, accessed February 8, 2025, https://www.bittorrent.com/en/support/solutions/articles/29000023347-what-is-seeding-.

[151] Krein Report ¶119.

there are no technical requirements that a peer remain active on the BitTorrent network as a seeder after it has completely downloaded all of the pieces of the torrent file's payload.[152]

91. The Krein Report alleges that Meta's download of the torrent payloads means that it subsequently acted as a seeder for the downloaded files. However, as I describe in **Section VI.B.2** below, the code implemented by Meta terminates the torrenting session as soon as it detects that the download has completed (i.e., within no more than 60 seconds of completion of the full torrent file download.) This action would disconnect any open peer connections, thereby significantly limiting the likelihood that Meta acted as a seeder for any of the torrented files.

92. Further, the implemented network configurations (as discussed in **Section VI.C.1**) would have prevented any new leechers from initiating a connection with Meta's instance during this (or any other) time window. Thus, the Krein Report's assumption that the downloading of a file via BitTorrent would have automatically led to seeding of that file is unfounded. As I discuss in the following sections, the safeguards implemented by Meta would have further significantly reduced the chance that Meta seeded any content, including any pieces containing the Plaintiffs' works.

B. Meta's Implemented Safeguards Rendered the Possibility of Seeding Highly Unlikely

93. The Krein Report repeatedly misrepresents the functionality of the source code implemented by Meta, specifically asserting that "is_seed() function […] checks whether a given file has been fully downloaded, at which point the file has become a seed for distribution to other peers in the network."[153] In this section, I respond to the Krein Report by highlighting the actual implementation of the code utilized, showcasing that the "**is_seed()**" function is used for checking the status during download, and subsequent removal of the torrent once the download is finished. I first provide an overview of the general torrent download functionality within

[152] "After a torrent job finishes downloading, you are highly **encouraged** to leave the torrent job seeding. Although the length of time that you should leave the file seeding **is not defined**." See: BitTorrent Limited, "Help Center - What Is Seeding?," BitTorrent, accessed February 8, 2025, https://www.bittorrent.com/en/support/solutions/articles/29000041669-what-is-seeding-.

[153] Krein Report ¶¶127, 168.

Meta's download scripts "**download_trnts.py**" and "**download_spark.py**". Interaction with the libtorrent library, and the BitTorrent protocol, is largely similar across both scripts, with differences limited to the manner in which parallel processing is implemented. I then outline how the safeguards implemented by Meta substantially limited the possibility of seeding Plaintiffs' works.

1) Overview of Meta's Torrent Download Source Code

94. As mentioned above, during my review of Meta's source code, I identified two source code files that manage BitTorrent downloads: "**download_trnts.py**" [154] and "**download_spark.py**,"[155] which were used to perform the torrent downloads, respectively, in 2023 (for "scimag" portions of LibGen) and in 2024 (for portions of Anna's Archive). Although only the latter script was used to download content including Plaintiffs' works using the BitTorrent protocol, my discussion will cover both scripts as they use the same logic for downloading large datasets via the BitTorrent client, in this case, libtorrent, a well-known open-source programming library for implementing the BitTorrent protocol. [156] The "**download_trnts.py**" script utilizes the "**download_torrent**" function, whereas the "**download_spark.py**" script utilizes an identical implementation in the "**_download**" function, described in more detail below, to initiate and handle the torrenting process. The differences between the two scripts lie in the way this common torrent mechanism is multitasked, such that "**download_trnts.py**" is designed to be executed multiple times in parallel on a single computer, whereas "**download_spark.py**" leverages the Python library[157] PySpark[158] to distribute processing multiple times in parallel across multiple computers, reducing overall download time.

[154] META-KADREY-SC-000202.

[155] META-KADREY-SC-000212.

[156] "Libtorrent," libtorrent, accessed February 5, 2025, https://www.libtorrent.org/.

[157] An external Python library is a collection of pre-written code modules created by others that can be installed and used in Python projects to add specific functionality or features without writing them from scratch.

[158] "PySpark Overview — PySpark 3.5.4 Documentation," accessed February 5, 2025, https://spark.apache.org/docs/latest/api/python/index.html.

95. As highlighted above, the "**download_torrent**" and the "**_download**" functions are the only components in the two source code files that interface with libtorrent and ultimately are responsible for downloading the torrent.[159,160] The implementation for handling the torrent files and downloading the payload are substantially identical between the two, with only minor differences as described below. The following steps are performed for each torrent file in both "**download_torrent**" and "**_download**" functions, in "**download_trnts.py**"[161] and "**download_spark.py**"[162] respectively, for downloading a particular torrent:

    a. A new libtorrent session is initiated, which serves as the central controller for managing torrent-related activities, including downloading files.[163,164,165]

    b. The torrent file information, such as the torrent info hash and corresponding piece hashes, are loaded into the machine/instance using libtorrent's "**torrent_info**" function.[166,167,168]

    c. A torrent is added to the libtorrent session using libtorrent's "**add_torrent**" function, providing the torrent file information and the path to the directory where the data downloaded from the torrent should be saved.[169] As soon as the "**add_torrent**" function is executed, libtorrent uses the BitTorrent protocol to begin participating in the BitTorrent network to obtain the indicated torrent payload files. This activity continues until the "**remove_torrent**" function is executed or the

[159] META-KADREY-SC-000202. Function "download_torrent" on line 38.

[160] META-KADREY-SC-000212. Function "_download" on line 78.

[161] META-KADREY-SC-000202. Function "download_torrent" on line 38.

[162] META-KADREY-SC-000212. Function "_download" on line 78.

[163] META-KADREY-SC-000202. Line 39.

[164] META-KADREY-SC-000212. Line 74.

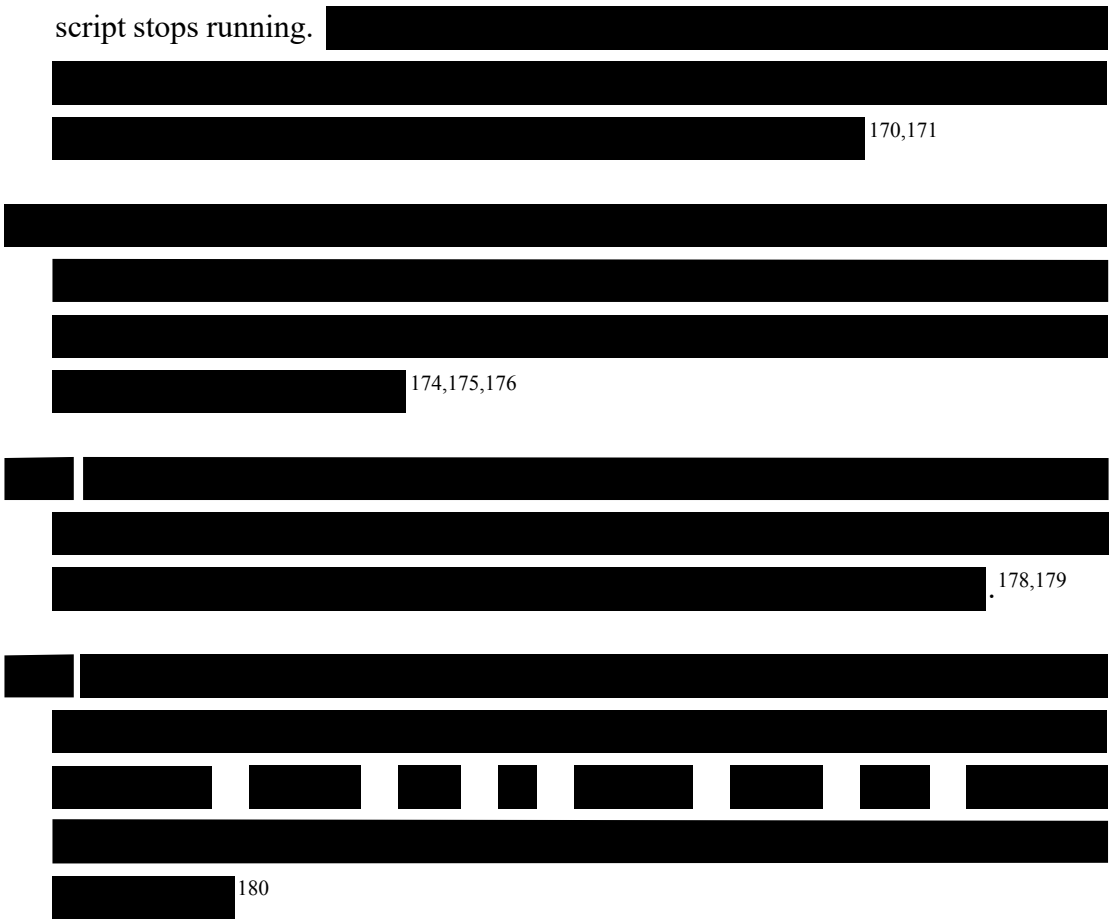
[165] "Libtorrent," libtorrent, accessed February 5, 2025, https://libtorrent.org/reference-Session.html#session.

[166] META-KADREY-SC-000202. Line 42.

[167] META-KADREY-SC-000212. Line 78.

[168] "Libtorrent," libtorrent, accessed February 5, 2025, https://libtorrent.org/reference-Torrent_Info.html#torrent_info.

[169] "Libtorrent," libtorrent, accessed February 5, 2025, https://libtorrent.org/reference-Session.html#add-torrent-async-add-torrent.



[170] META-KADREY-SC-000202. Line 43.

[171] META-KADREY-SC-000212. Line 83.

[172] META-KADREY-SC-000202. Line 55.

[173] META-KADREY-SC-000212. Line 92.

[174] META-KADREY-SC-000202. Line 47.

[175] META-KADREY-SC-000212. Line 85.

[176] "Libtorrent/Src/Torrent_handle.Cpp at 57fd4e452eff0466957460b1608b96719599076e · Arvidn/Libtorrent," GitHub, accessed February 6, 2025, https://github.com/arvidn/libtorrent/blob/57fd4e452eff0466957460b1608b96719599076e/src/torrent_handle.cpp.

[177] Polling occurs when the source code repeatedly queries or checks the status of something at regular intervals.

[178] META-KADREY-SC-000202. Lines 48-50.

[179] META-KADREY-SC-000212. Lines 86-90.

[180] "**remove_torrent()** will close all peer connections associated with the torrent and tell the tracker that we've stopped participating in the swarm. This operation cannot fail." See: "Libtorrent," libtorrent, accessed February 5, 2025, https://libtorrent.org/reference-Session.html#remove-torrent.

g. At this point, the torrent download process is complete and the function responsible for downloading the torrent ends. This means the libtorrent session object is automatically destroyed, and no seeding of the downloaded content to other peers can occur.

96. [redacted]

97. Every step described above is implemented within both "**download_trnts.py**" and "**download_spark.py**." [redacted]

2) Meta's Source Code Removes Torrents from the Session Within No More Than 60 Seconds of Download Completion

98. A key component of the torrent download process in Meta's environment is the "**is_seed**" loop that monitors the status of the download, removing the torrent from the active session within no more than 60 seconds of completion. The body of the Krein Report asserts that the

[181] "**remove_torrent()** will close all peer connections associated with the torrent and tell the tracker that we've stopped participating in the swarm. This operation cannot fail." See: "Libtorrent," libtorrent, accessed February 5, 2025, https://libtorrent.org/reference-Session.html#remove-torrent.

[182] META-KADREY-SC-000212. Lines 27-30.

"**is_seed**" function "checks whether a given file has been fully downloaded, at which point the file has become a seed for distribution to other peers in the network."[183] The Krein Report misstates the function of this loop, generally referencing it in his discussion of the torrent downloader scripts,[184] only acknowledging the actual purpose of it at the end of an appendix.[185] **Figure 2** below demonstrates Meta's implementation of the "**is_seed**" loop.

Figure 2 - Sixty Second Polling of is_seed() Loop[186]

99. [redacted]

[183] Krein Report ¶¶127, 168.

[184] Krein Report ¶162.

[185] Krein Report ¶212.

[186] META-KADREY-SC-000213. Lines 85-93.

[187] Although the download_spark.py script uses Python's "logging" library, no filename is specified in the logging.basicConfig, resulting in the logs being written out to the console during download, and not to a persistent file. In any case, these log statements would not provide information on whether particular pieces, or the identity of those pieces, were uploaded from Meta's instances. The logging in download_spark.py is instead limited to reporting download progress over time. META-KADREY-000212.

100. In my opinion, it is highly unlikely that seeding of any of Plaintiffs' works, would have occurred during this short time window after the download of the torrent file was complete. As I will explain in more detail in **Section VI.C.2** below, each of the Plaintiffs' works represents a very small fraction of the content of the downloaded payload, so the likelihood that a peer would have sought to download a piece containing one of Plaintiffs' works, during the small time window between when Meta completed the download and disconnected the torrent, is exceedingly low. Meta also implemented network-level safeguards blocking ingress traffic (**Section VI.C.1** below) that further limit the possibility of seeding Plaintiffs' works to leechers, by accepting connections only from those peers to whom Meta previously initiated a connection and thus rejecting all new incoming requests, including those that might be attempted within the 60 second window after torrent download completion. In sum, Meta took steps to prevent seeding data downloaded via BitTorrent, and these steps should have prevented any distribution of Plaintiffs' works by Meta. As a result, it is not surprising that the Krein Report does not point to any evidence that seeding actually occurred.

C. Seeding Plaintiffs' Works is Also Unlikely Due to Meta's Network Configuration and Other Factors

101. In **Sections VI.C.1** below I discuss how network-level safeguards, the size and scale of the at-issue datasets, the proportion of those datasets that comprise Plaintiffs' works, other libtorrent defaults, and BitTorrent protocol behavior generally, all make it unlikely that Plaintiffs' works were seeded by Meta.

1) Meta's Network Configuration Blocks Inbound Traffic

102. The Krein Report claims that "the download_spark.py script includes a call to the is_seed() function, which checks whether a given file has been fully downloaded, at which point the file has become a seed for distribution to other peers in the network."[188] This statement, at best, describes default functionality of the BitTorrent protocol, and does not take into account the safeguards that Meta implemented to reject incoming requests from other peers on the network. As I explain below, the network environment that Meta used to perform the torrent downloads

[188] Krein Report ¶168.

disallows inbound requests from connections that have not been initiated by Meta, further reducing the possibility of seeding.

103. A ***firewall*** is a network security system that monitors and regulates incoming and outgoing traffic based on predefined security rules. It acts as a barrier between a trusted internal network and untrusted external networks, such as the internet, to prevent unauthorized access and communication.[189]

104. I confirmed with a Meta engineer that the torrent downloads initiated in 2024 took place on an Amazon Web Services (AWS) instance, which is also consistent with contemporaneous documents and deposition testimony provided in the case.[190,191,192] AWS is a cloud services platform that offers a number of services including processing and computing power, storage, database technologies, analytics, and other features.[193] AWS services are often provided through AWS "instances," which are computing resources made available to customers such as Meta.[194] In Meta's AWS cloud environment, torrenting was performed within a Virtual Private Cloud (VPC)—a logically isolated virtual network within a public cloud[195]—where "security groups" act as virtual firewalls. These security groups control traffic at the instance level by specifying rules that determine which connections are allowed or denied.[196]

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[189] "What Is a Firewall?," Cisco, accessed February 5, 2025, https://www.cisco.com/site/us/en/learn/topics/security/what-is-a-firewall.html.

[190] "What is an Instance in Cloud Computing?," Amazon, accessed February 8, 2025, https://aws.amazon.com/what-is/cloud-instances/.

[191] Deposition of David Esiobu, December 13, 2024, 168:14-21 (discussing Exhibit 811, Meta_Kadrey_00108336).

[192] Interview with Meta engineers Xiaolan Wang and David Esiobu. Mr. Esiobu confirmed that he set up the AWS instances for the torrent download for Ms. Wang, which Ms. Wang used for the actual download. *See also* Deposition of David Esiobu, December 13, 2024, 168:14-21 (discussing provisioning AWS instances for Ms. Wang to perform torrent download process).

[193] "Cloud Computing with AWS," accessed February 8, 2025, https://aws.amazon.com/what-is-aws/.

[194] "What is an Instance in Cloud Computing?," Amazon, accessed February 8, 2025, https://aws.amazon.com/what-is/cloud-instances/.

[195] "What Is Amazon VPC? - Amazon Virtual Private Cloud," accessed February 5, 2025, https://docs.aws.amazon.com/vpc/latest/userguide/what-is-amazon-vpc.html.

[196] "Control Traffic to Your AWS Resources Using Security Groups - Amazon Virtual Private Cloud," accessed February 5, 2025, https://docs.aws.amazon.com/vpc/latest/userguide/vpc-security-groups.html.

105. In AWS, a software tool referred to as "Terraform" is used to configure security settings, including firewalls in the form of security groups. By default, AWS security groups operate on a "deny-all" model for inbound traffic, blocking any connections that are not explicitly permitted.[197] Updates to security groups can be managed through Terraform configuration files. For example, a security group can be defined using the "aws_security_group" block in a Terraform file, specifying ingress rules to control incoming network traffic.[198]

106. I obtained the Terraform configuration file for the AWS instances used to perform the torrent downloads of Anna's Archive in 2024, which I understand was stored on the Meta source code computer made available during discovery.[199] Meta defined two explicit ingress rules in its Terraform configuration file to allow (i) Secure Shell (SSH) connections and (ii) internal traffic.[200] These two rules modify the default behavior of the security groups, which is to block all inbound requests, effectively defining two narrow 'exceptions' to the deny-all inbound traffic default configuration. The first rule permits SSH traffic specifically to port 22, but only from a predefined set of IP addresses associated with Meta VPNs.[201,202] This ensures that only authorized users connecting through the VPN can securely access the AWS cloud resources via SSH. The second rule allows unrestricted traffic between AWS resources within

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[197] "[N]o inbound traffic is allowed until you add inbound rules to the security group" "Security Group Rules - Amazon Virtual Private Cloud," accessed February 5, 2025, https://docs.aws.amazon.com/vpc/latest/userguide/security-group-rules.html.

[198] "Aws_security_group | Resources | Hashicorp/Aws | Terraform | Terraform Registry," accessed February 5, 2025, https://registry.terraform.io/providers/hashicorp/aws/latest/docs/resources/security_group.html.

[199] [redacted] During my interview with him, Mr. David Esiobu confirmed that this was the Terraform network configuration file he used for the AWS instances used for the Anna's Archive torrent download that took place in 2024. A copy of this configuration file has been provided with my report.

[200] [redacted]

[201] A Virtual Private Network (VPN) is a secure, encrypted connection that allows users to access a private network over the internet, ensuring data privacy and protection from unauthorized access. In cloud environments, VPNs are often used to securely connect remote users or on-premises networks to cloud resources, enabling secure communication as if they were within the same internal network. "What Is a Virtual Private Network (VPN)?," Cisco, accessed February 5, 2025, https://www.cisco.com/c/en/us/products/security/vpn-endpoint-security-clients/what-is-vpn.html.

[202] [redacted]

the same security group.[203] Neither of these exceptions permit leechers to originate new inbound BitTorrent connections.

Figure 3 – Ingress Rule Allowing SSH Only From Meta VPNs[204]

```
############### Security groups
resource "aws_security_group" "meta_vpn_and_self_ingress" {
  name   = replace("${var.environment}-meta-vpn-and-self-ingress", "_", "-")
  vpc_id = aws_vpc.vpc.id

  ingress {
    description = "Restrict SSH to meta VPNs"
    protocol    = "tcp"
    from_port   = 22
```

[redacted]

Figure 4 – Ingress Rule Allowing All Traffic from Instances With the Same Security Group[205]

[redacted]

107. Consequently, Meta's network configuration restricted the circumstances under which Meta could potentially seed data to other peers in a torrent swarm. Because all inbound connections are blocked by default, leechers would have been unable to initiate direct requests for pieces from Meta unless Meta was the originator of the connection. Security groups are stateful, only permitting return traffic for outbound connections, meaning Meta must have first established an outbound connection to a peer before that peer can receive any pieces from Meta.[206] This setup restricts incoming requests for downloading data from Meta and ensures that Meta could only upload a piece of a file to a peer in situations where Meta had

[203] [redacted]. Lines 57-63.

[204] [redacted] Lines 49-55.

[205] [redacted]. Lines 57-63.

[206] "Security groups are stateful. For example, if you send a request from an instance, the response traffic for that request is allowed to reach the instance regardless of the inbound security group rules." "Control Traffic to Your AWS Resources Using Security Groups - Amazon Virtual Private Cloud," accessed February 5, 2025, https://docs.aws.amazon.com/vpc/latest/userguide/vpc-security-groups.html.

affirmatively initiated the connection to the peer, reducing the likelihood of seeding data to peers in the swarm.

108. To verify that Meta's network configuration functions as intended, I designed a brief experiment using an AWS environment configured identically to Meta's using the Meta Terraform configuration file settings. From my experiment, I confirmed that the AWS instances used by Meta to perform the torrent downloads would have blocked any incoming requests to their IP addresses. My findings and methodologies are described in **Appendix A** below.[207]

109. In sum, the AWS environment and torrenting source code scripts used for Meta's torrenting process provided multiple independent safeguards against seeding with other leechers in the swarm. I will describe below how these, along with other factors, would have made it highly unlikely that Meta would have seeded Plaintiffs' works to other peers on the network.

2) Plaintiffs' Works Constitute Exceedingly Small Portions of the Datasets at Issue

110. The size and scale of the at-issue datasets, relative to the size of the Plaintiffs' works in those datasets, is another important consideration in assessing the likelihood, or unlikelihood, that Meta would have seeded Plaintiffs' works to other peers. Using the data from the comprehensive manual Anna's Archive search that I discussed in **Section V.B.2**, I identified the occurrences of each of the Plaintiffs' works in torrent files for each dataset that was downloaded using the BitTorrent protocol. **Table 2** below summarizes the total number of times Plaintiffs' works were identified in each of the datasets downloaded by Meta, using the BitTorrent protocol:

[207] As I explained in **Section V.B.2**, there is no evidence that the torrent downloads in 2023 of the "scimag" portion of LibGen involved any of Plaintiffs' works. I note, however, that the Meta dev server system used by Mr. Bashlykov to perform those downloaded appeared to have included substantially similar firewall protections as the AWS instances described in the text. *See* 30(b)(6) Deposition of N. Bashlykov, December 6, 2024, 50:9-22 ("Q. Did you look at any other documents that discuss seeding? A. I looked into the internal documentation which specifies which ports open on the dev servers. Q. '… internal documentation which specifies which ports open on the dev servers.' What does that mean? A. So Meta dev servers, they have some firewall protection. I refreshed my recollection on what ports are open to the outside or which ones are not."). I interviewed Mr. Bashlykov, who confirmed that he used Meta dev servers to do the "scimag" torrent downloads in 2023.

Table 2 – Number of Downloaded Plaintiffs' Works Across Torrented Datasets

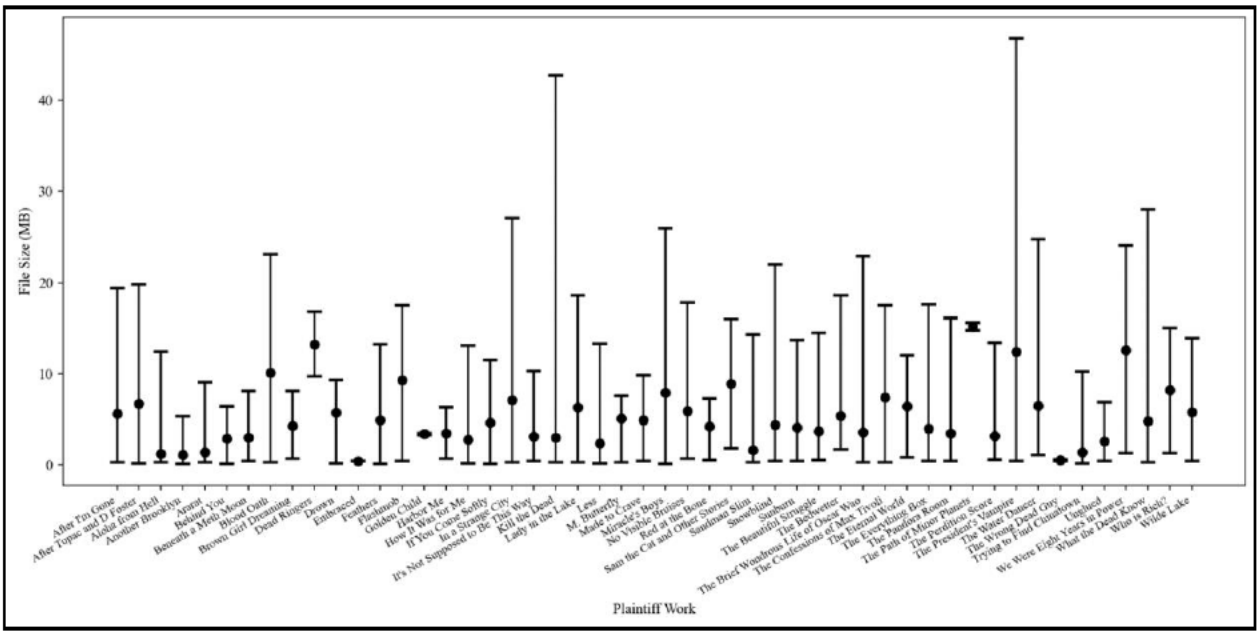
Dataset	Total Number of Instances of Downloaded Plaintiffs' At-Issue Works in Dataset
Libgen.rs Non-Fiction (Scitech Only)[208]	3
Libgen.rs "scimag"	0
Internet Archive (IA)	174
Z-Library (ZLib)	489

111. The first item in **Table 2** shows that, for Libgen.rs Non-Fiction, only three copies of Plaintiffs' works were downloaded. This does not represent three distinct books; it represents a single book (Ta-Nehisi Coates, *The Beautiful Struggle*), which was repeated three times in the downloaded dataset. No other Plaintiff works are contained in this dataset. The repetition of books is a prevalent characteristic of these datasets; as shown by the numbers for IA and ZLib above, Plaintiffs' works often appear multiple times within each dataset.

112. Even taking this duplication into account, the size of each Plaintiff work occurrence is not consistent within or across the at-issue datasets. For example, the file sizes associated with occurrences of some Plaintiff books may be disproportionately larger than other books due to factors such as embedded graphics or the automated text recognition program used for text extraction. Because these factors may impact the proportion of each Plaintiff work within a dataset, they also impact the likelihood that a piece of the work could be seeded to other peers on the BitTorrent network. **Figure 5** below presents an analysis of the wide range of file sizes a given Plaintiff work exhibits across all at-issue datasets. For each work, the vertical bar represents the variation in size of different copies of the work as they occur in the at-issue datasets. See **Appendix B** for details on methodology of identifying the size of the Plaintiffs' works within the at-issue datasets.

[208] Only includes Plaintiffs' works in torrent files downloaded by Meta identified as part of the Scitech portion of Libgen.rs Non-Fiction (r_3650000.torrent to r_ 4142000.torrent). Torrents - Anna's Archive," accessed February 5, 2025, https://web.archive.org/web/20240324090640/https://annas-archive.org/torrents/libgen_rs_non_fic.

Figure 5 – Plaintiff Work File Size Variations Across At-Issue Datasets[209]



113. Regardless of these differences, the proportion of each Plaintiff work (and all Plaintiffs' works combined) to the overall size of each at-issue dataset is negligible. To calculate this proportion, the file sizes were summed across all occurrences of Plaintiffs' works in each dataset, then divided that by the sum of the file sizes downloaded for the overall dataset. Metrics on the combined file sizes and the associated proportion of the Plaintiffs' works are summarized in **Table 3** below. See **Appendix B** for details on methodology of identifying the proportion of the Plaintiffs' works within the at-issue datasets.

[209] Some Plaintiffs' works titles truncated for visual purposes.

Table 3 - Size of Plaintiffs' Works Across Torrented Datasets

Dataset	Total Size of Downloaded Dataset[210,211]	Proportion of Plaintiff Works[212]			
		Average	Lowest	Highest	Total
Libgen.rs Non-Fiction (Scitech Only)	10.3 TB[213]	7.5 MB (0.00007%)[214]			
Internet Archive (IA)	193.5 TB	48.2 MB (0.000024%)	6.8 MB (0.0000033%)	215.9 MB (0.00011%)	2311.9 MB (0.0011%)
Z-Library (ZLib)	63.6 TB	11.0 MB (0.000017%)	0.1 MB (0.00000015%)	57.2 MB (0.000086%)	518.5 MB (0.00078%)

114. Even the highest proportion of all occurrences of a Plaintiff's work over any of the at-issue datasets is a negligible percentage. For example, there are 12 occurrences in IA of the Plaintiff Laura Lippman's work, *What the Dead Know*, but this makes up only 0.00011% of the data in that dataset (with a combined file size of 215.9 MB across all occurrences). This represents the highest proportion of any individual Plaintiff work (by size) for any of the at-issue datasets. **Figure 6** illustrates the vast scale of IA relative to this Plaintiff work.

[210] Process for calculating total download size for each at-issue dataset is discussed in **Appendix B**.

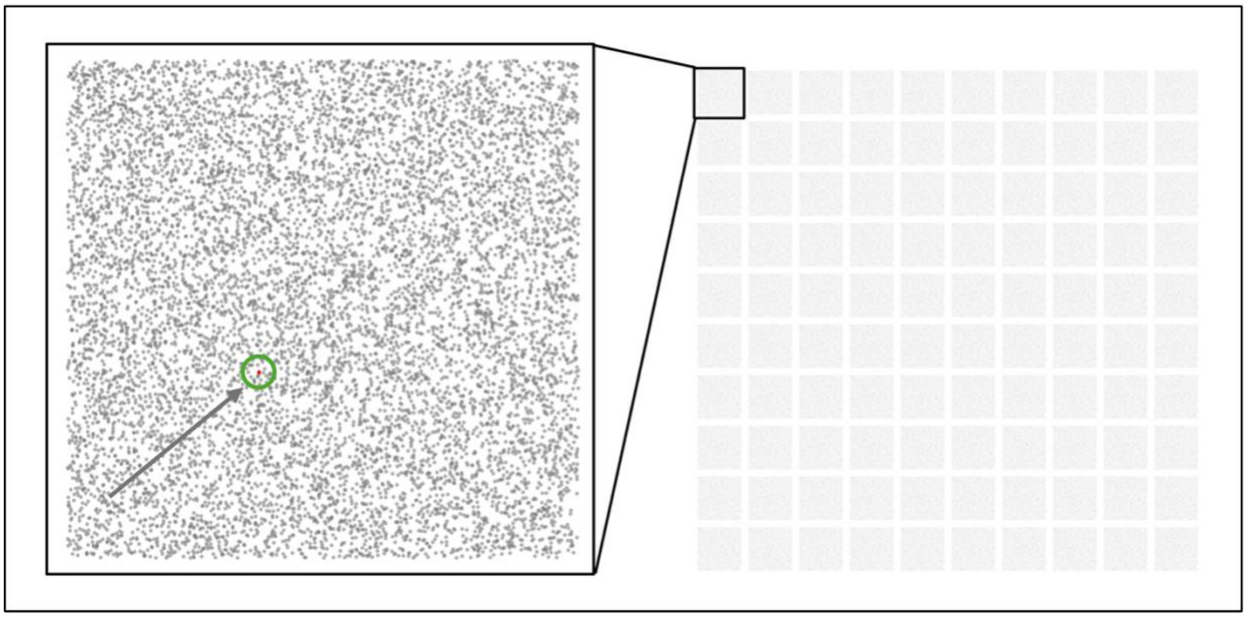
[211] These calculated total download sizes for each of the at-issue datasets are consistent with internal communications in Meta_Kadrey_00107954.

[212] Metrics calculated using aggregated file sizes of all occurrences of a Plaintiff's work in the given dataset.

[213] Only includes Plaintiffs' works in torrent files downloaded by Meta identified as part of the Scitech portion of Libgen.rs Non-Fiction (r_3650000.torrent to r_ 4142000.torrent). Torrents - Anna's Archive," accessed February 5, 2025, https://web.archive.org/web/20240324090640/https://annas-archive.org/torrents/libgen_rs_non_fic.

[214] Only one unique Plaintiff work in Scitech portion of Libgen.rs Non-Fiction, therefore, all metrics are the same when grouped by work.

Figure 6 – Scale of At-Issue Dataset to a Plaintiff Work



115. A single point within a vast collection illustrates the minimal proportion of a Plaintiff's work relative to the datasets that contain them. On the left of **Figure 6**, 10,000 points are displayed, with one highlighted in red. On the right of **Figure 6**, 100 of these 10,000-point plots collectively represent the scale of the entire IA dataset. Only one of these 100 plots contains a single red point, visually depicting the 0.00011% proportion of *What the Dead Know* within the dataset, the highest of any Plaintiffs' works in any of the at-issue datasets.

116. For the ZLib dataset, all of Plaintiffs' books combined make up 0.00078% (78 ten-thousandths of one percent) of the downloaded dataset, as shown in **Table 3**. For example, if one visualizes the ZLib dataset as a book with a million pages, all of Plaintiffs' works combined would make up roughly eight pages of that book. Similarly, if ZLib were represented as the 52 mile distance between San Jose and San Francisco, Plaintiffs' books combined would stretch roughly two feet.[215] For the IA dataset, all of Plaintiffs' books combined make up 0.0011% (11 thousandths of one percent) of the downloaded dataset, as shown in **Table 3**. Using the same analogy of a book with a million pages representing the IA dataset, all of Plaintiffs' works combined would make roughly 11 pages of that book. And

[215] 0.00078% of 274,560 (number of feet from San Jose to San Francisco, based on 52 miles * 5280 feet per mile).

using the same analogy of the distance from San Jose to San Francisco, all of Plaintiffs' books in the IA dataset would stretch roughly three feet.

117. The proportion of Plaintiffs' works to the sizes of the torrent files that contain them was also calculated. First, the maximum number of pieces that each work occurrence could span was calculated by dividing the work occurrence file size by the piece size, rounding up and adding one.[216] These values were summed to calculate the total number of pieces across all torrent files in which Plaintiffs' works appear. Metrics on the number of torrents downloaded by Meta that contained Plaintiffs' works, and the proportion of Plaintiffs' works to other data in the torrents, is illustrated in **Table 4** below. See **Appendix B** for details on methodology of identifying the proportion of the Plaintiffs' works within the at-issue torrents.

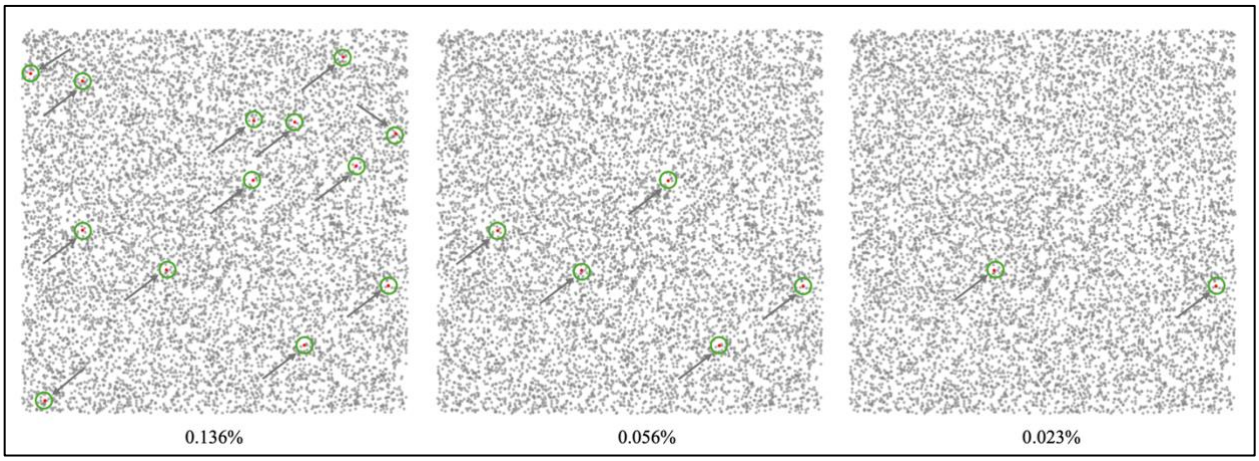
Table 4 - Proportion of Plaintiffs' Works Across Downloaded Torrent Files

Dataset	Total Torrents Downloaded	Total Number of Torrent Files Downloaded Containing Plaintiffs' Works	Proportion of Pieces in Torrent Files Containing Plaintiffs' Works
Libgen.rs Non-Fiction (Scitech Only)	491	2	0.136%
Internet Archive (IA)	143	46	0.056%
Z-Library (ZLib)	265	146	0.023%

118. The proportions of all occurrences of a Plaintiff's work over any of the at-issue torrents is a negligible percentage. For example, there are 46 torrent files with at least one of the Plaintiffs' works in IA, however, only 0.056% of the pieces in these 46 torrent files contain any part of the Plaintiffs' works. **Figure 7** illustrates the vast scale of all the pieces in the IA torrents containing Plaintiffs' works relative to pieces that actually contain Plaintiffs' works.

[216] Calculating the maximum number of pieces containing a given work occurrence using this method is an overestimate and assumes the worst case: that each of the Plaintiffs' works is spread out across the maximum number of pieces that it could be based on the file size and piece size for the torrent. Therefore, the proportions provided in **Table 4** are all upper-bound values.

Figure 7 – Visualization of Proportion of Plaintiffs' Works Within Libgen.rs Non-Fiction, Internet Archive, and Z-Library Torrent Files that Contain Plaintiffs' Works



119. Each box in **Figure 7** contains 10,000 points, as a representation of the torrents downloaded by Meta within Libgen.rs Non-Fiction (Scitech only), IA, and ZLib. The red dots represent the proportion of Plaintiffs' works pieces within the torrent files that contain any Plaintiffs' works: 13 out of 10,000 for Libgen.rs Non-Fiction, 5 out 10,000 for IA and 2 out of 10,000 for Z-Lib. These dots visually represent the small percentages of Plaintiffs' works within the torrent files that contain them, that were downloaded by Meta.

120. For the ZLib dataset, all the pieces containing Plaintiffs' works combined make up 0.023% of the torrent files that contain Plaintiff works (a subset of all downloaded torrent files), as shown in **Table 4**. If ZLib were represented as the 52 mile distance between San Jose and San Francisco, as analogized above, all the pieces of the Plaintiffs' works would be a little less than two bus lengths.[217] For the IA dataset, all the pieces of the Plaintiffs' works combined make up 0.056% of the torrent files that contain Plaintiff works. Using the same analogy of the distance from San Jose to San Francisco, all of Plaintiffs' books in the IA dataset would stretch roughly over four bus lengths.

121. The small proportion of Plaintiffs' works to the sizes of the at-issue datasets, as well as the small proportion of Plaintiffs' work pieces within the torrents they exist in, are important factors that further drive down the possibility that these works would have been seeded to other

[217] 0.023% of 274,560 (number of feet from San Jose to San Francisco, based on 52 miles * 5280 feet per mile). One bus length is roughly 35 feet.

peers on the network. Leechers do not download an entire payload from a single seeder when multiple seeders are present in the swarm. For Meta to have seeded a piece containing one of Plaintiffs' works to a leecher, therefore, would have required: that (i) Meta had previously initiated a connection to the leecher and that connection was still open (as any leecher to whom Meta did not initiate a connection would have been blocked by the firewall rules as described above), (ii) Meta has used one of its unchoke slots to unchoke that leecher, rather than some other peer, and then (iii) the leecher asked Meta (rather than some other peer to which the leecher was connected) for that particular piece (out of the vast number of other pieces that do not contain any of Plaintiffs' works). Because Plaintiffs' works individually and collectively constitute a negligible percentage of the overall payload, it is unlikely that Meta was asked to seed the precise pieces containing Plaintiffs' works. This is further reinforced by (iv), the 60 second period described above, which provides the maximum window in which any seeding could have theoretically occurred, after which the torrent file is removed immediately. The additional constraints imposed by libtorrent settings and the BitTorrent protocol, which I discuss in more detail in the next section, make this even less likely to have occurred.

3) Libtorrent Default Settings and BitTorrent Protocol Behavior Further Diminished the Likelihood of Seeding

122. The Krein Report does not consider important default settings in the libtorrent library used by Meta,[218] and other aspects of the BitTorrent Protocol that further limit Meta's ability to seed. As previously discussed in **Section IV.B**, the choking and unchoking process determines the number of peers with whom a leecher can exchange data at any given time. Seeding is restricted by the applied choking algorithm, which can limit the number of peers it can upload to at once using a pre-determined number of unchoke slots.

123. The default libtorrent choking algorithm used during seeding limits the number of unchoke slots. During seeding, libtorrent uses the **round_robin** algorithm, which maintains a constant maximum of unchoked slots, but periodically round-robins the peers that are unchoked while seeding. The **unchoke_slots_limit** setting determines the maximum number of concurrently unchoked peers. Further, the **unchoke_interval** determines how often peers are re-evaluated

[218] Interview with Meta engineer, Xiaolan Wang. I confirmed that Meta did not modify the libtorrent source code.

for being choked/unchoked. Using the same libtorrent version that Meta used for the torrent download,[219] I verified the default settings to confirm the choking algorithm, maximum number of unchoke slots, and the unchoke interval. As a result, Meta could not have been uploading data to more than eight peers at any specific point in time while seeding, and even then, any peers within these eight could have been rotated for a choked peer, every 15 seconds.[220] Coupled with the extremely small percentage of pieces in the at-issue torrent payloads that comprise Plaintiffs' works, this further limits the likelihood that Plaintiffs' works would have been seeded by Meta to other peers.

124. Further, the mere presence of leechers in a torrent swarm does not necessarily indicate the seeding of Plaintiffs' works by Meta. At any given time, the number of leechers in the swarm fluctuates, and not all leechers require every piece of the torrent. Leechers that are downloading torrents over time may have already obtained the pieces containing Plaintiffs' works from other peers on the network or in prior paused sessions, eliminating the need for those leechers to obtain those pieces from Meta. Even if a leecher in the swarm is seeking a piece that contains one of Plaintiff's works, Meta could only provide the piece if it was currently connected and had currently unchoked the leecher, and if the leecher chose to send that particular piece request to Meta as opposed to another seeder or leecher that had the piece. The pieces prioritized for download by other leechers will also change dynamically.

125. The rarest-piece-first strategy in the BitTorrent protocol, which I discussed in **Section IV.C.2**, prioritizes downloading the least common pieces of a torrent first. Because the rarity of pieces changes dynamically based on the composition of the swarm, and the availability within the swarm of specific pieces at any given moment, it is not possible to determine which pieces were considered "rare" when Meta was downloading the at-issue torrents in 2024, and given the constantly shifting nature of piece rarity, it is impossible to determine with certainty whether pieces containing Plaintiffs' works were ever prioritized as "rare" or deprioritized.

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[219] Version 2.0.9, based on an interview with Xiaolan Wang. I also confirmed that version 2.0.9 would have been the latest stable release of libtorrent at the time of torrent download in or about April 2024. *See,* "Libtorrent: Python Bindings for Libtorrent-Rasterbar," accessed February 10, 2025, https://pypi.org/project/libtorrent/2.0.9/#history.

[220] There is also a concept of optimistic unchoking, wherein libtorrent reserves 20% of the unchoke slots (1, given 8 as default), to unchoke a new choked peer every 30 seconds.

Nevertheless, even if pieces containing Plaintiffs' work were rare at one point in time, all of the seeders in the swarm would be known to have had them, and other leechers already in the swarm who did not already have the piece would have been prioritizing downloading the rarer pieces from other peers even before Meta joined. On the other hand, if Plaintiffs' works were already well-distributed among the swarm, it is even less likely that Meta would have seeded those pieces to other peers, given their low rarity.

4) Likelihood that All Necessary Conditions Aligned for Meta to Upload Plaintiff's Works During Download is Substantially Limited

126. As I outline above, several factors had to have aligned sequentially and simultaneously for Meta to have seeded pieces of a torrent that contain Plaintiffs' works to leechers:

127. **Meta must have previously initiated a connection with the leecher.** This would have been required in light of the firewall protections described in **Section VI.C.1**. This would also have been unlikely to have occurred during the 60 second maximum time window in which seeding could have theoretically occurred because, at that point, Meta would not have required pieces of that torrent file from other peers and thus would not have initiated connections with other peers.

128. **The leecher must not have already possessed the pieces containing Plaintiffs' works.** Obviously, the leecher may not have required all, or any, of the particular pieces containing Plaintiffs' works (which as explained comprise a tiny fraction of the at-issue datasets). Leechers that existed in the swarm and who had been actively downloading may already have possessed the pieces of the torrent containing Plaintiffs' works.

129. **The leecher must have been requesting the specific pieces containing the small portions of Plaintiffs' works.** Even if Meta had connected to the leecher, and the leecher had not already downloaded the pieces containing the Plaintiffs' works, the next condition would have been that the leecher must have been actively requesting one of those pieces (either because the piece was randomly selected or because the piece was deemed rare). Although piece rarity is dynamic and cannot be determined for the time Meta conducted the download, this condition would also need to have been aligned (except on a peer's initial requests, when a small number of pieces may be requested randomly). In any case, it must have been aligned

that the pieces requested by the leecher were the ones that contained Plaintiffs' works. As noted in **Section VI.C.2**, this is a rare occurrence given the negligible percentage of pieces in the at-issue datasets that contained Plaintiffs' works.

130. **The leecher must select Meta as the seeder to upload these pieces.** At this stage, the leecher must have also decided to select Meta as the peer from which to download the pieces and sent its piece request to Meta. Therefore, for Meta to have seeded pieces containing Plaintiff's works, two additional key factors must have aligned: (i) the sequential satisfaction of all prior conditions that make Meta a viable source for the piece, and (ii) the simultaneous, selection of Meta as the preferred peer for the download over all other available peers that have the piece. Only if both of these additional conditions were met could Meta have been the particular peer that seeded Plaintiffs' works to leechers.

131. **Meta must have been able to seed pieces containing Plaintiffs' works within a maximum of 60 seconds.** As outlined in **Section VI.B.2**, Meta's torrent download scripts limited the amount of time a torrent could theoretically have been seeding. By polling the **h.is_seed()** loop every 60 seconds, Meta set an upper bound for how long a torrent could have theoretically been seeded after torrent download completion, as the file is removed as soon as **h.is_seed()** is returned as true. Therefore, for Meta to have seeded pieces containing Plaintiffs' works, all the prior conditions need to have been sequentially satisfied, Meta had to have been chosen as the peer from which to download, and the upload of the pieces to the leecher must have occurred within this brief time window before the torrent was removed.

132. **A leecher must have remained in Meta's unchoked slots long enough to download a piece containing Plaintiffs' works.** As discussed in **Section VI.C.3**, during seeding, libtorrent uses a round-robin method of unchoking, checking the eight unchoke slots every 15 seconds, and potentially rotating out peers. Further, optimistic unchoking rotates out 1 unchoked leecher for a choked leecher every 30 seconds. Therefore, even though Meta could potentially have been seeding for a maximum of 60 seconds after completion of the torrent download, a leecher would have had to occupy one of the eight unchoked slots, with a possibility of only being allowed to download for 15 seconds before being choked again.

133. To recap, for Meta to have seeded pieces containing Plaintiffs' works, all of the following conditions must have coalesced: (i) Meta must have previously and affirmatively initiated a connection with a leecher, (ii) the leecher must not have already downloaded the pieces containing Plaintiffs' works and must also be prioritizing those pieces for download, (iii) the pieces being prioritized must contain the portion of data out of all the data in the dataset that contains a given Plaintiff's works, (iv) out of all the peers the leecher is connected to that also have the piece, Meta must have been the one chosen as the source for seeding, (v) Meta must seed pieces to the leecher that contain Plaintiff works' within the (at maximum) 60 seconds of Meta's torrent download completion, and finally (vi) a leecher must remain in Meta's unchoked slots long enough to download a piece containing Plaintiffs' works.

134. All of these constraints and conditions must have been met in order for Meta to have seeded a piece containing the Plaintiffs' works. Considering the factors discussed above, any contention in the Krein Report that Meta uploaded Plaintiffs' works to peer on the BitTorrent network (which is not demonstrated with any evidence) would be nothing more than speculation and conjecture, given the many factors identified above. In light of all of the factors discussed above, in my opinion, it is exceedingly unlikely that Meta seeded any of the Plaintiffs' works.

VII. CONCLUSION

135. In this report, I respond to several inaccurate, misleading, and incomplete assertions the Krein Report makes regarding Meta's use of "BitTorrent," the potential "seeding" of data, and Meta's environment for performing torrent downloads. Based on my analysis, I demonstrate that the Krein Report (i) misunderstands and mischaracterizes the BitTorrent protocol when suggesting Meta necessarily seeded data, (ii) does not consider the safeguards implemented by Meta to prevent the seeding of downloaded data nor the myriad of unlikely factors that would have needed occur for seeding to take place, and (iii) presents no evidence that Plaintiffs' works were actually seeded by Meta (as opposed to other data in the at-issue datasets, which has also not been demonstrated), and rather only speculates that this was the case based on the existence of torrenting scripts in Meta's codebase.

136. As I discuss in **Section VI.B** and **Section VI.C**, Meta had safeguards built in that prevent seeding such as (i) removing the torrent from the session within no more than 60 seconds after the torrent download has completed, and (ii) blocking all unsolicited inbound connections, effectively rejecting requests from un-connected leechers during the brief 60 second period.

137. Further, in order for Meta to have seeded Plaintiffs' works, many different practical and technical factors would have had to come together that, in my opinion, make it highly unlikely that this occurred, as described in the preceding section. I note that the Krein Report does not present any evidence that Meta actually seeded data, let alone that Meta seeded any of the Plaintiffs' works.

138. In sum, based on the safeguards implemented by Meta, the numerous factors in the torrent network that would have needed to align, and the small proportion of Plaintiffs' works in the at-issue datasets (as discussed in **Section VI.C.2**), it is highly unlikely that Meta seeded the Plaintiffs' works to other peers during any of the torrent downloads discussed above.

VIII. APPENDIX A: VALIDATION OF META'S NETWORK CONFIGURATION

140. In this section, I present the results of an experiment conducted to verify Meta's network configuration. As discussed in **Section VI.C.1**, the torrenting process ran on an AWS instance, with the network configurations implemented using the "**networking.tf**" file. Below, I discuss an empirical experiment to test whether an instance created using Meta's network configuration denies incoming requests.

141. An AWS EC2 instance was created, using the same network configuration as outlined in the "**networking.tf**" file, allowing SSH access to a set of Meta VPNs, and blocking all incoming traffic by default (see **Figure 3** and **Figure 4**). To verify incoming and outgoing connections to this instance, VPC Flow Logs were enabled on the VPC within which this instance exists. A discussed in **Section VI.C.1** above, a VPC is a Virtual Private Cloud, a logically isolated virtual network within a public cloud where "security groups" act as virtual firewalls. VPC Flow Logs allow logging of inbound and outbound IP traffic from network interfaces that are within the VPC.[221]

142. With the AWS EC2 instance active, and VPC Flow Logs enabled, requests were made from two local IP addresses, using the netcat (nc) command. Netcat is a Linux/Unix utility that is used to read and write data to IP addresses using either the TCP or UDP protocol.[222] Netcat was selected as it also allows for selection of source and destination ports, which was set to 6881 for both, to maintain consistency with a torrent download.[223]

143. To verify whether Meta's network configuration blocked incoming requests and traffic, **nc** was used from the two local IP addresses, to send a connection to the AWS EC2 instance. The two IP addresses used were, IP address 1: 100.35.182.212, and IP address 2: 63.125.113.158. The netcat command used to send a request to the AWS EC2 instance was **nc -p 6881**

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[221] "Logging IP Traffic Using VPC Flow Logs - Amazon Virtual Private Cloud," accessed February 9, 2025, https://docs.aws.amazon.com/vpc/latest/userguide/flow-logs.html.

[222] "Netcat Man," Linux Command Library, accessed February 9, 2025, https://linuxcommandlibrary.com/man/netcat.

[223] "Typically, BitTorrent uses TCP as its transport protocol. The well known TCP port for BitTorrent traffic is 6881-6889." "BitTorrent - Wireshark Wiki," accessed February 9, 2025, https://wiki.wireshark.org/BitTorrent.

3.147.28.112 6881 for TCP and **nc -u -p 6882 3.147.28.112 6882** for UDP.[224] **Nc** requests were made from the local IP addresses to the AWS EC2 instance, while the VPC Flow Logs monitored traffic to and from the VPC.

144. First, the test was run for TCP traffic. All incoming requests were rejected and logged as "REJECT" in the VPC Flow Logs until an outbound nc request was made from the AWS EC2 instance to one of the local IP addresses (**nc -p 6881 100.35.182.212 6881**). Once the stateful security group captured an outbound request to IP 100.35.182.212 (Rows 5 and 7) the next inbound request from that local IP address was accepted and logged as an "ACCEPT" in the logs (Row 8). **Table 5** below captures the inbound and outbound traffic on TCP port 6881 of the AWS EC2 instance, while this experiment was being conducted.

Table 5 – VPC Flow Logs for TCP Traffic[225]

#	srcaddr	dstaddr	srcport	dstport	protocol	packets	start	end	action
1	100.35.182.212	10.0.1.200	6881	6881	6	12	1739052875	1739052903	REJECT
2	63.125.113.158	10.0.1.200	6881	6881	6	6	1739052875	1739052903	REJECT
3	100.35.182.212	10.0.1.200	6881	6881	6	2	1739052903	1739052934	REJECT
4	63.125.113.158	10.0.1.200	6881	6881	6	6	1739052903	1739052934	REJECT
5	10.0.1.200	100.35.182.212	6881	6881	6	1	1739052935	1739052962	ACCEPT
6	63.125.113.158	10.0.1.200	6881	6881	6	7	1739052964	1739052991	REJECT
7	10.0.1.200	100.35.182.212	6881	6881	6	10	1739052995	1739053021	ACCEPT
8	100.35.182.212	10.0.1.200	6881	6881	6	3	1739052995	1739053021	ACCEPT

145. Then, the test was run for UDP traffic. All incoming requests were rejected and logged as "REJECT" in the VPC Flow Logs until an outbound nc request was made from the AWS EC2 instance to one of the local IP addresses (**nc -u -p 6882 100.35.182.212 6882**). Only after the stateful security group captured an outbound request to IP 100.35.182.212 (Row 5) was the next inbound request from that local IP address accepted and logged as an "ACCEPT" in the

[224] The "-p" flag is used to specify the source port, and the -u flag is to set UDP.

[225] Five columns are dropped from the VPC Flow Logs for representation purposes. The version (which is always 2), the account-id (the account identifier of the AWS account), the interface-id (unique identifier of the particular EC2 instance), the bytes (size of packets sent), and the log-status (which tracks whether the traffic was captured successfully). The logs with the columns included have been provided with my report, as AWS VPC Flow Logs_TCP.log, and AWS VPC Flow Logs_UDP.log.

logs (Row 7). **Table 6** below captures the inbound and outbound traffic on UDP port 6882 of the AWS EC2 instance, while this experiment was being conducted.

Table 6 – VPC Flow Logs UDP Traffic

#	srcaddr	dstaddr	srcport	dstport	protocol	packets	start	end	action
1	100.35.182.212	10.0.1.200	6882	6882	17	1	1739212803	1739212831	REJECT
2	63.125.113.158	10.0.1.200	6882	6882	17	1	1739212838	1739212858	REJECT
3	100.35.182.212	10.0.1.200	6882	6882	17	1	1739212838	1739212858	REJECT
4	63.125.113.158	10.0.1.200	6882	6882	17	1	1739212864	1739212893	REJECT
5	10.0.1.200	100.35.182.212	6882	6882	17	2	1739212896	1739212923	ACCEPT
6	63.125.113.158	10.0.1.200	6882	6882	17	1	1739212925	1739212952	REJECT
7	100.35.182.212	10.0.1.200	6882	6882	17	2	1739212983	1739213001	ACCEPT

146. This experiment confirms that Meta's AWS network configuration would have blocked unsolicited inbound requests and traffic, and traffic from IP addresses would only have been accepted if Meta had already initiated an outbound connection to those IP addresses.

IX. APPENDIX B: METHODOLOGY FOR COMPUTING SIZE OF PLAINTIFFS' WORKS WITHIN AT-ISSUE DATASETS

147. After manually collecting metadata associated with each occurrence of Plaintiffs' works from Anna's Archive, which I discussed in **Section V.B.2**, several scripts were used to gather and analyze additional data to support my opinions in this report. This appendix identifies all scripts used to attribute books to relevant datasets, identify occurrences downloaded by Meta, collect torrent file metadata, and calculate metrics for the Plaintiffs' work size experiment.

148. Along with these scripts, the input spreadsheet (**step-01.xlsx**), which contains the manual search results for all Plaintiffs' works in Anna's Archive, and all intermediate results generated that lead to the final outputs presented in this report are included. The input spreadsheet **step-01.xlsx** contains fields for the Author, Book, URL, MD5 Hash, Server Path, File Size,[226] and Torrent Files associated with the work occurrence indexed by Anna's Archive.

149. The manual search results include 1,217 occurrences of Plaintiffs' works indexed by Anna's Archive across multiple datasets. However, not all occurrences are present in the at-issue torrented datasets for this report. Additionally, these 1,217 instances of Plaintiffs' works reflect the current number of occurrences, which is likely higher than it would have been in about April 2024 when the torrent download took place.

150. For torrent file associations, some works have no associated torrent files, some have one, and others appear in multiple. If a work occurrence lacks an associated torrent file, it indicates that no bulk torrents exist for that file, meaning Meta did not torrent it as part of their bulk downloads. If a work occurrence (i.e., a single, unique MD5 hash) is associated with multiple torrent files, that means it appears in multiple distinct datasets.

151. The server path provides the absolute path, including the torrent filename and the individual filename of the downloaded work occurrence. This metadata is essential for identifying which work occurrences were downloaded by Meta in an upcoming analysis, using the file-level download lists provided by the Meta engineer.

[226] File size in megabytes (MB) from Anna's Archive page converted to bytes in **step-01.xlsx** spreadsheet by multiplying the megabytes value by 1,048,576 to obtain the bytes value (1 MB = 1,048,576 bytes).

152. Next, the **verify_dataset.py** script is used to associate each occurrence with one of the at-issue datasets. The dataset associations are determined based on torrent file naming patterns:

a. LibGen Non-Fiction (including the Scitech collection): Torrent files start with the prefix "r_".

b. LibGen Scimag: Torrent files start with the prefix "sm_".

c. ZLib: Torrent files contain the term "zlib".

d. IA: Torrent files contain the term "ia".

153. Using these patterns, each occurrence is classified into an at-issue dataset and saved in an updated spreadsheet with the fields "is_nonfic", "is_scimag", "is_zlib", and "is_ia".[227] The raw counts of work occurrences in each dataset from this step are shown in **Table 7** below. This analysis confirms that none of the Plaintiffs' works appear in the LibGen Scimag dataset.

Table 7 - Number of Plaintiffs' Works Across Complete Datasets Currently Available on Anna's Archive

Dataset	Total Number of Plaintiffs' Works in Dataset
Libgen.rs Non-Fiction	67
Libgen.rs "scimag"	0
Internet Archive (IA)	205
Z-Library (ZLib)	532

154. While **verify_dataset.py** confirms which occurrences associate with each at-issue dataset, not all occurrences were downloaded by Meta. An engineer at Meta provided file-level lists for the individual files downloaded in 2024 from ZLib (**meta_zlib_downloads.txt**), IA (**meta_ia_downloads.txt**), and the portion of the downloaded LibGen Non-Fiction SciTech collection (**meta_nonfic_downloads.txt**). The file-level lists include the server path of the file, therefore, the server path for each work occurrence appears in only needs to be checked

[227] The "step-02.xlsx" spreadsheet is generated by the **verify_dataset.py** script.

within the corresponding file-level downloads list. The **verify_downloaded.py** script is used to determine which work occurrences were downloaded by Meta; these counts are presented in **Table 2**. To signify whether Meta downloaded the work occurrence, the column "Meta Downloaded?" is added and set to true or false.[228]

155. The final metric required for the Plaintiffs' works file size analysis is the total amount of data downloaded by Meta for each at-issue dataset. The file-level lists mentioned above include a field indicating the file size in bytes for each downloaded file. By summing these values, the total data downloaded by Meta for each dataset was obtained. To calculate these metrics, the **get_total_download.py** script was used, which informed subsequent scripts requiring the total downloaded data for each dataset. **Table 8** below summarizes these totals.

156. The final metrics required for the Plaintiffs' works piece size analysis is the number of pieces and piece size for each torrent file containing any of the Plaintiffs' works. To obtain these metrics, the torrent files were downloaded (**zlib-torrents** folder for ZLib, **ia-torrents** folder for IA, and **nonfic-torrents** folder for LibGen Non-Fiction SciTech collection)[229] and their contents were analyzed for each of the at-issue datasets. The piece level metrics are saved to json files for each at-issue dataset: ZLib (**zlib_piece_metrics.json**), IA (**ia_piece_metrics.json**), and the portion of the downloaded LibGen Non-Fiction SciTech collection (**nonfic_piece_metrics.json**). The **collect_piece_metrics.py** script collects this data and creates these JSON files with the piece metrics.[230] The **get_piece_metrics.py** script pulls this data from the JSON files into the spreadsheet.[231] The **get_total_download.py** script is also used to output the total number of unique torrent files downloaded by Meta. **Table 8** below summarizes these totals.

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[228] The "step-03.xlsx" spreadsheet is generated by the **verify_downloaded.py** script.

[229] Unzip the **dataset-torrents.zip** file and move the extracted folders into the data/ directory for use with **collect_piece_metrics.py**.

[230] One ZLib torrent file is unable to be parsed and is flagged as an error when running this script (pilimi-zlib-120000-419999.torrent). Therefore, no piece metrics are extracted for this torrent file, however, it was manually confirmed that no Plaintiffs' works are contained in this torrent file, so it has no effect on analyses in the upcoming steps.

[231] The "step-04.xlsx" spreadsheet is generated by the **get_size_metrics.py** script.

Table 8 – Total Data Downloaded from At-Issue Datasets

Dataset	Total Torrent Files Downloaded	Total Data Downloaded (bytes)	Total Data Downloaded (TB)
Libgen.rs Non-Fiction	491	11,265,886,570,904	10.3
Internet Archive (IA)	143	212,711,620,545,935	193.5
Z-Library (ZLib)	265	69,880,971,467,008	63.6

157. At this stage, all necessary data is organized to generate the figures and metrics included in my report. For **Figure 5**, the **visualize_size_ranges.py** script was used to aggregate file size metrics for all downloaded Plaintiffs' work occurrences across the at-issue datasets and generate a plot with the minimum, maximum, and average file size across all of the occurrences.

158. To calculate the size of the Plaintiffs' works across the at-issue datasets at the file-level, as presented in **Table 3**, the **get_size_metrics.py** script was used. This script groups file size data for each work occurrence within each at-issue dataset separately and computes the proportion based on the overall dataset sizes from historical Anna's Archive snapshots from April 2024. Additionally, in **Appendix C.A** the per work occurrence file sizes for each of the downloaded Plaintiffs' works is included, generated with the same **get_size_metrics.py** script and saved to separate spreadsheets for each dataset. The metrics are illustrated for IA in **Table 9**, ZLib in **Table 10**, and LibGen Non-Fiction in **Table 11**.

159. Similarly, to calculate the size of the Plaintiffs' works across the at-issue datasets at the piece-level, as presented in **Table 4**, the **get_size_metrics.py** script is also used. This script groups piece size data for each work occurrence within each at-issue dataset separately and computes the proportion based on the total number of pieces across the torrent files containing that particular work. Additionally, in **Appendix C.B** the per work occurrence piece sizes for each of the downloaded Plaintiffs' works is included, generated with the same **get_size_metrics.py** script and saved to separate spreadsheets for each dataset.[232] This script

[232] The "step-05-ia-file.xlsx," "step-05-ia-piece.xlsx," "step-05-nonfic-file.xlsx," "step-05-nonfic-piece.xlsx," "step-05-zlib-file.xlsx," and "step-05-ia-piece.xlsx" spreadsheets are generated by the **get_size_metrics.py** script. The spreadsheets are categorized by dataset and file- or piece-level metrics.

also outputs the number of unique torrent files containing Plaintiffs' works for each at-issue dataset. The metrics are illustrated for IA in **Table 12**, ZLib in **Table 13**, and LibGen Non-Fiction in **Table 14**.

160. Lastly, the point plots used in **Figure 6** and **Figure 7** were generated using the **create_point_plots.py** script. This script also generated the 10x10 grid of point plots used in **Figure 6** on the right. This script uses a list of plot versions with names and the percentage of points to highlight to generate a series of plots and save the plots accordingly.

X. APPENDIX C: DATA TABLES FOR SIZES OF PLAINTIFFS' WORKS ACROSS AT-ISSUE DATASETS

A. File-level Analysis of Sizes of Plaintiffs' Works

161. **Tables 9, 10, and 11** in this section demonstrate the size of Plaintiffs' works across Libgen.rs Non-Fiction (Scitech), IA, and ZLib based on a file-level analysis. The **Occurrences** column counts the number of times the book appears in the dataset, the **Average Size** is the average file size in megabytes across the work's occurrences, and the **Std Size** represents the standard deviation of the file size across the work's occurrences. The **Total Size** represents a sum of the file sizes of all the work's occurrences, with the **Portion of Dataset** representing the **Total Size** divided by the total size of the datasets downloaded by Meta.

Table 9 - Downloaded Per-Work File Size Metrics Across IA

Plaintiff Work	Occurrences	Average Size (MB)	Std Size (MB)	Total Size (MB)	Portion of Dataset (%)
After I'm Gone	7	14.8	3.7	103.9	0.00005122
After Tupac and D Foster	1	19.8	0	19.8	0.00000976
Aloha from Hell	1	12.4	0	12.4	0.00000611
Another Brooklyn	2	5.1	0.2	10.3	0.00000508
Ararat	1	9.1	0	9.1	0.00000449
Behind You	2	5.6	1.1	11.3	0.00000557
Beneath a Meth Moon	2	6.5	2.3	13	0.00000641
Blood Oath	6	16.5	3.8	99.2	0.0000489
Brown Girl Dreaming	2	8	0.1	16	0.00000789
Dead Ringers	2	13.2	5	26.5	0.00001306
Drown	8	7.5	1.3	60	0.00002958
Feathers	3	8.1	4.5	24.4	0.00001203
Flashmob	4	15.8	1.2	63.4	0.00003125
Golden Child	2	3.4	0.1	6.8	0.00000335
Harbor Me	2	6.3	0	12.6	0.00000621

Plaintiff Work	Occurrences	Average Size (MB)	Std Size (MB)	Total Size (MB)	Portion of Dataset (%)
How It Was for Me	1	13.1	0	13.1	0.00000646
If You Come Softly	5	7	2.7	35	0.00001725
In a Strange City	5	21.4	5.3	107.1	0.0000528
It's Not Supposed to Be This Way	3	9	1.6	26.9	0.00001326
Kill the Dead	1	42.7	0	42.7	0.00002105
Lady in the Lake	4	15.9	2	63.8	0.00003145
Less	5	11.6	2	58	0.00002859
M. Butterfly	4	6	1.9	24.1	0.00001188
Made to Crave	4	8.1	1.5	32.4	0.00001597
Miracle's Boys	5	9.5	9.4	47.4	0.00002337
No Visible Bruises: What we don't know about domestic violence can kill us	1	17.8	0	17.8	0.00000877
Red at the Bone	7	6.3	0.5	44.2	0.00002179
Sam the Cat and Other Stories	1	16	0	16	0.00000789
Sandman Slim	2	13.4	1.2	26.9	0.00001326
Snowblind: A Novel	3	18.4	3.6	55.1	0.00002716
Sunburn	6	11.3	1.7	67.8	0.00003342
The Beautiful Struggle	5	10.4	3.2	52.1	0.00002568
The Bedwetter	4	13.8	3.2	55.1	0.00002716
The Brief Wondrous Life of Oscar Wao	10	16.5	3.9	165.3	0.00008149
The Confessions of Max Tivoli	7	14.1	2.2	99	0.0000488
The Eternal World	1	12	0	12	0.00000592
The Everything Box	1	17.6	0	17.6	0.00000868
The Pandora Room	1	16.1	0	16.1	0.00000794

Plaintiff Work	Occurrences	Average Size (MB)	Std Size (MB)	Total Size (MB)	Portion of Dataset (%)
The Path of Minor Planets	2	15.2	0.6	30.4	0.00001499
The Perdition Score	3	13.2	0.2	39.7	0.00001957
The President's Vampire	3	32.4	16.6	97.1	0.00004787
The Water Dancer	5	21.3	2.2	106.5	0.0000525
Trying to Find Chinatown	2	6.3	5.5	12.6	0.00000621
Unglued	3	6.8	0.2	20.4	0.00001006
We Were Eight Years in Power	5	21	3.3	105	0.00005176
What the Dead Know	12	18	4.2	215.9	0.00010643
Who is Rich?	3	12.9	2.3	38.7	0.00001908
Wilde Lake: A Novel	5	12.3	1.5	61.4	0.00003027

Table 10 - Downloaded Per-Work File Size Metrics Across ZLib

Plaintiff Work	Occurrences	Average Size (MB)	Std Size (MB)	Total Size (MB)	Portion of Dataset (%)
After I'm Gone	13	0.6	0.5	7.8	0.0000117
After Tupac and D Foster	2	0.2	0	0.4	0.0000006
Aloha from Hell	31	0.9	1.1	27.6	0.00004141
Another Brooklyn	40	0.9	0.5	36.6	0.00005492
Ararat	12	0.7	0.6	9	0.0000135
Behind You	2	0.1	0	0.2	0.0000003
Beneath a Meth Moon	3	0.7	0.3	2.2	0.0000033
Blood Oath	4	0.4	0.1	1.5	0.00000225
Brown Girl Dreaming	7	3.2	1.6	22.3	0.00003346
Drown	3	0.7	0.9	2.2	0.0000033
Embraced	1	0.4	0	0.4	0.0000006

Plaintiff Work	Occurrences	Average Size (MB)	Std Size (MB)	Total Size (MB)	Portion of Dataset (%)
Feathers	2	0.1	0.1	0.3	0.00000045
Flashmob	3	0.6	0.3	1.9	0.00000285
Harbor Me	2	0.7	0.1	1.5	0.00000225
How It Was for Me	4	0.3	0	1.1	0.00000165
If You Come Softly	3	0.7	1	2.1	0.00000315
In a Strange City	11	0.6	0.1	6.1	0.00000915
It's Not Supposed to Be This Way	8	0.9	0.5	7.1	0.00001065
Kill the Dead	19	0.9	0.8	17.5	0.00002626
Lady in the Lake	10	2.4	2	24.1	0.00003616
Less	43	1.3	1	57.2	0.00008583
M. Butterfly	2	3.4	4.4	6.8	0.0000102
Made to Crave	3	0.7	0.5	2.1	0.00000315
Miracle's Boys	1	0.1	0	0.1	0.00000015
No Visible Bruises: What we don't know about domestic violence can kill us	3	1.9	2.1	5.8	0.0000087
Red at the Bone	4	0.5	0.1	2.2	0.0000033
Sam the Cat and Other Stories	1	1.8	0	1.8	0.0000027
Sandman Slim	28	0.8	0.5	22.5	0.00003376
Snowblind: A Novel	13	1.1	0.5	14.9	0.00002236
Sunburn	15	1.2	1.1	18.6	0.00002791
The Beautiful Struggle	12	1.3	0.9	15.2	0.00002281
The Bedwetter	10	2	0.7	20	0.00003001
The Brief Wondrous Life of Oscar Wao	43	0.6	0.4	24.3	0.00003646
The Confessions of Max Tivoli	7	0.7	0.3	5	0.0000075

Plaintiff Work	Occurrences	Average Size (MB)	Std Size (MB)	Total Size (MB)	Portion of Dataset (%)
The Eternal World	1	0.8	0	0.8	0.0000012
The Everything Box	4	0.6	0.2	2.5	0.00000375
The Pandora Room	8	1.9	2	15.2	0.00002281
The Perdition Score	14	1.1	0.5	15	0.00002251
The President's Vampire	5	0.4	0.1	2.2	0.0000033
The Water Dancer	15	1.6	0.3	23.9	0.00003586
The Wrong Dead Guy	4	0.5	0.1	2.2	0.0000033
Trying to Find Chinatown	9	0.3	0.2	3.1	0.00000465
Unglued	8	1.1	0.7	8.7	0.00001305
We Were Eight Years in Power	5	4.3	2.2	21.5	0.00003226
What the Dead Know	42	1	1	41.4	0.00006212
Who is Rich?	3	3.6	3.9	10.7	0.00001606
Wilde Lake: A Novel	6	0.5	0.1	2.9	0.00000435

Table 11 - Downloaded Per-Work File Size Metrics Across LibGen Non-Fiction

Plaintiff Work	Occurrences	Average Size (MB)	Std Size (MB)	Total Size (MB)	Portion of Dataset (%)
The Beautiful Struggle	3	2.5	1.6	7.5	0.00006981

B. Piece-level Analysis of Sizes of Plaintiffs' Works

162. **Tables 12, 13, and 14** in this section demonstrate the size of Plaintiffs' works across Libgen.rs Non-Fiction (Scitech), IA, and ZLib based on a piece-level analysis. The **Number of Unique Torrent Files Containing Work Occurrences** is the number of torrent files in the dataset that contained at least one occurrence of the associated Plaintiff work. The **Number of Pieces Containing Work Occurrences** is the upper-bound number of pieces that could contain any parts of the associated Plaintiff work. The **Total Number of Pieces Across Torrent Files** is the sum of the number of pieces in the unique torrent files containing the associated work's occurrences. The **Portion of Torrent Files** is the percentage of pieces containing the work's occurrences out of the total number of pieces across the unique torrent files containing associated work occurrences.

Table 12 - Downloaded Per-Work Piece Size Metrics Across IA

Plaintiff Work	Number of Unique Torrent Files Containing Work Occurrences	Number of Pieces Containing Work Occurrences[233]	Total Number of Pieces Across Torrent Files	Portion of Torrent Files (%)
After I'm Gone	3	14	36746	0.038099
After Tupac and D Foster	1	2	1118	0.178891
Aloha from Hell	1	2	1118	0.178891
Another Brooklyn	1	4	8352	0.047893
Ararat	1	2	8352	0.023946
Behind You	1	4	9306	0.042983
Beneath a Meth Moon	2	4	24499	0.016327
Blood Oath	4	12	20101	0.059699
Brown Girl Dreaming	1	4	9306	0.042983
Dead Ringers	1	4	7248	0.055188

[233] This is the sum of the maximum number of pieces a Plaintiff work can exist in. The formula used to compute the pieces is ceil(plaintiff file size/piece size) + 1, to account for a work being spread across multiple pieces.

Plaintiff Work	Number of Unique Torrent Files Containing Work Occurrences	Number of Pieces Containing Work Occurrences[233]	Total Number of Pieces Across Torrent Files	Portion of Torrent Files (%)
Drown	6	16	45143	0.035443
Feathers	3	6	12727	0.047144
Flashmob	2	8	11928	0.067069
Golden Child	2	4	11421	0.035023
Harbor Me	2	4	7999	0.050006
How It Was for Me	1	2	6881	0.029066
If You Come Softly	1	10	12688	0.078815
In a Strange City	2	10	29682	0.03369
It's Not Supposed to Be This Way	2	6	13806	0.043459
Kill the Dead	1	2	1118	0.178891
Lady in the Lake	1	8	1118	0.715564
Less	4	10	18062	0.055365
M. Butterfly	2	8	18410	0.043455
Made to Crave	1	8	9701	0.082466
Miracle's Boys	4	10	20646	0.048436
No Visible Bruises: What we don't know about domestic violence can kill us	1	2	1118	0.178891
Red at the Bone	2	14	18112	0.077297
Sam the Cat and Other Stories	1	2	12428	0.016093
Sandman Slim	1	4	1118	0.357782
Snowblind: A Novel	2	6	25691	0.023354

Plaintiff Work	Number of Unique Torrent Files Containing Work Occurrences	Number of Pieces Containing Work Occurrences[233]	Total Number of Pieces Across Torrent Files	Portion of Torrent Files (%)
Sunburn	1	12	1118	1.073345
The Beautiful Struggle	3	10	11542	0.08664
The Bedwetter	3	8	18775	0.04261
The Brief Wondrous Life of Oscar Wao	5	20	27368	0.073078
The Confessions of Max Tivoli	4	14	48787	0.028696
The Eternal World	1	2	7105	0.028149
The Everything Box	1	2	1118	0.178891
The Pandora Room	1	2	1118	0.178891
The Path of Minor Planets	1	4	9378	0.042653
The Perdition Score	1	6	1118	0.536673
The President's Vampire	3	6	11614	0.051662
The Water Dancer	1	10	1118	0.894454
Trying to Find Chinatown	1	4	6320	0.063291
Unglued	2	6	4187	0.143301
We Were Eight Years in Power	4	10	14366	0.069609
What the Dead Know	5	24	29149	0.082336
Who is Rich?	2	6	6903	0.086919
Wilde Lake: A Novel	2	10	12205	0.081934

Table 13 - Downloaded Per-Work Piece Size Metrics Across ZLib

Plaintiff Work	Number of Unique Torrent Files Containing Work Occurrences	Number of Pieces Containing Work Occurrences[234]	Total Number of Pieces Across Torrent Files	Portion of Torrent Files (%)
After I'm Gone	12	26	100509	0.025868
After Tupac and D Foster	2	4	40113	0.009972
Aloha from Hell	22	62	245064	0.0253
Another Brooklyn	17	80	130285	0.061404
Ararat	11	24	156546	0.015331
Behind You	2	4	36624	0.010922
Beneath a Meth Moon	3	6	51959	0.011548
Blood Oath	4	8	25231	0.031707
Brown Girl Dreaming	5	15	73323	0.020457
Drown	3	6	20584	0.029149
Embraced	1	2	24332	0.00822
Feathers	2	4	39432	0.010144
Flashmob	3	6	29004	0.020687
Harbor Me	2	4	26955	0.01484
How It Was for Me	4	8	80553	0.009931
If You Come Softly	3	6	25016	0.023985
In a Strange City	10	22	124441	0.017679
It's Not Supposed to Be This Way	5	16	61147	0.026166
Kill the Dead	16	38	115129	0.033006
Lady in the Lake	10	21	133173	0.015769

[234] This is the sum of the maximum number of pieces a plaintiff work can exist in. The formula used to compute the pieces is ceil(plaintiff file size/piece size) + 1, to account for a work being spread across multiple pieces.

Plaintiff Work	Number of Unique Torrent Files Containing Work Occurrences	Number of Pieces Containing Work Occurrences[234]	Total Number of Pieces Across Torrent Files	Portion of Torrent Files (%)
Less	35	86	349533	0.024604
M. Butterfly	2	5	28792	0.017366
Made to Crave	2	6	22360	0.026834
Miracle's Boys	1	2	11398	0.017547
No Visible Bruises: What we don't know about domestic violence can kill us	3	6	18258	0.032862
Red at the Bone	3	8	1798	0.444939
Sam the Cat and Other Stories	1	2	15729	0.012715
Sandman Slim	20	56	164425	0.034058
Snowblind: A Novel	12	26	153673	0.016919
Sunburn	15	30	181667	0.016514
The Beautiful Struggle	11	24	196288	0.012227
The Bedwetter	9	20	49080	0.04075
The Brief Wondrous Life of Oscar Wao	28	86	329448	0.026104
The Confessions of Max Tivoli	7	14	84000	0.016667
The Eternal World	1	2	13959	0.014328
The Everything Box	4	8	44550	0.017957
The Pandora Room	7	16	93782	0.017061
The Perdition Score	6	28	95023	0.029467

Plaintiff Work	Number of Unique Torrent Files Containing Work Occurrences	Number of Pieces Containing Work Occurrences[234]	Total Number of Pieces Across Torrent Files	Portion of Torrent Files (%)
The President's Vampire	5	10	34437	0.029039
The Water Dancer	12	30	185177	0.016201
The Wrong Dead Guy	4	8	32266	0.024794
Trying to Find Chinatown	3	18	26083	0.06901
Unglued	5	16	88526	0.018074
We Were Eight Years in Power	4	11	50512	0.021777
What the Dead Know	26	84	259288	0.032396
Who is Rich?	3	6	53607	0.011193
Wilde Lake: A Novel	5	12	56166	0.021365

Table 14 - Downloaded Per-Work Piece Size Metrics Across LibGen Non-Fiction

Plaintiff Work	Number of Unique Torrent Files Containing Work Occurrences	Number of Pieces Containing Work Occurrences[235]	Total Number of Pieces Across Torrent Files	Portion of Torrent Files (%)
The Beautiful Struggle	2	7	5163	0.13558

[235] This is the sum of the maximum number of pieces a plaintiff work can exist in. The formula used to compute the pieces is ceil(plaintiff file size/piece size) + 1, to account for a work being spread across multiple pieces.

XI. APPENDIX D: MATERIALS CONSIDERED

Academic Articles

1. Jahn Arne Johnsen and Lars Erik Karlsen, "Peer-to-Peer Networking with BitTorrent," https://web.cs.ucla.edu/classes/cs217/05BitTorrent.pdf.
2. Jeffrey L Eppinger, "TCP Connections for P2P Apps." http://reports-archive.adm.cs.cmu.edu/anon/isri2005/CMU-ISRI-05-104.pdf.
3. Salman A. Baset and Henning Schulzrinne, "An Analysis of the Skype Peer-to-Peer Internet Telephony Protocol" (arXiv, December 5, 2004), https://doi.org/10.48550/arXiv.cs/0412017.
4. Adele Lu Jia and Dah Ming Chiu, "Designs and Evaluation of a Tracker in P2P Networks," in 2008 Eighth International Conference on Peer-to-Peer Computing (2008 Eighth International Conference on Peer-to-Peer Computing (P2P), Aachen, Germany: IEEE, 2008), 227–30, https://doi.org/10.1109/P2P.2008.11.

Produced Data and Source Code Files

1. META-KADREY-SC-000103 (2024-03-16 download_trnts.py).
2. META-KADREY-SC-000197 (download_libgen_direct.py).
3. META-KADREY-SC-000202 (2024-08-21 download_trnts.py).
4. META-KADREY-SC-000205 (download_trnts_list.py).
5. META-KADREY-SC-000206 (utils.py).
6. META-KADREY-SC-000212 (download_spark.py).
7. META-KADREY-SC-000467 (process_utils.py).
8. fair_data/cpu_spark/cluster_setup/terraform/setup_infra_module/networking.tf.

Internal Documents

1. meta_ia_download.txt (This file contains a listing of all IA works Meta downloaded on the AWS instance in 2024).
2. meta_zlib_downloads.txt (This file contains a listing of all ZLib works Meta downloaded on the AWS instance in 2024).
3. meta_nonfic_downloads.txt (This file contains a listing of all LibGen Non-Fiction works Meta downloaded on the AWS instance in 2024).

Produced Documents

1. Meta_Kadrey_00065244.
2. Meta_Kadrey_00107954.
3. Meta_Kadrey_00088043.
4. Meta_Kadrey_00168648.
5. Meta_Kadrey_00211852.
6. Meta_Kadrey_00108336.

Interviews

1. Interview with Meta engineer, Nikolay Bashlykov.
2. Interview with Meta engineer, Xiaolan Wang.
3. Interview with Meta engineer, David Esiobu.

Depositions

1. 30(b)(1) Deposition of N. Bashlykov, December 5-6, 2024.
2. 30(b)(6) Deposition of N. Bashlykov, December 6, 2024.
3. 30(b)(6) Deposition of Michael Patrick Clark, November 13, 2024.
4. Deposition of David Esiobu, December 13, 2024.

Textbooks

1. Computer Networking: A Top-Down Approach.

Expert Reports

1. Opening Expert Report of Jonathan L. Krein.
2. Opening Expert Report of Cristina Videira Lopes.

Web Sources

1. "A Brief History of Skype - the Peer to Peer Messaging Service," accessed February 5, 2025, https://content.dsp.co.uk/history-of-skype.
2. "About BitTorrent | Creator of the World's Leading P2P Protocol," BitTorrent, accessed February 5, 2025, https://www.bittorrent.com/company/about-us/ ("Before BitTorrent, file downloads were initiated from a centralized server or a single user (a peer), resulting in slow download speeds. The BitTorrent protocol addressed this limitation by enabling the download and upload of files between many users. Millions of users began to use the BitTorrent protocol to download and share files, and companies began to use the protocol to distribute data more efficiently. Today, the BitTorrent protocol powers a significant percentage of the world's Internet traffic each day. It isn't just the largest Peer-to-Peer network, it's the foundation of Web3, and one of the Internet's largest global communities. Proof that the technology is more relevant than ever, robust, and now driven by the power of blockchain.").
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XII. APPENDIX E: CURRICULUM VITAE

Curriculum Vitae, Qualifications, Testimony

Barbara A. Frederiksen-Cross

JurisLogic, LLC.
850 NW Summit Avenue
Portland, OR 97210-2816
Tel: (503) 200-2738

barb@jurislogic.com

Qualifications

Education and Experience

Barbara Frederiksen received her basic education at American public schools and completed her High School education at Chemeketa Community College, at the age of sixteen.

She continued her education there, receiving an Associate of Applied Science degree in Computer Programming in 1974 at the age of eighteen.

Since then, she has continued her professional education with technical training from IBM, Amdahl, Hitachi Data Systems, Verhoef, SAS Institute, Merrill Consultants, Microsoft, and other education providers. This education has included advanced training in operating system internals, telecommunication system internals, database internals, diagnostics, system performance engineering, storage management, capacity planning, and data recovery.

Ms. Frederiksen has 50 years' experience in the computer industry and has held positions as, in chronological order: mainframe and midrange applications programmer; system analyst; software development consultant; programming instructor (developing courses in CICS, OS JCL, and VSAM internals); database administrator; systems programmer (problem diagnosis, maintenance and customization of mainframe operating system software and other software products); system performance specialist (for batch, on-line, and database systems); regional manager for a software consulting service provider; operating systems software developer (developing software to enhance the performance of mainframe computing systems); systems programmer (performing hardware planning and performance evaluation, system tuning, network tuning, disaster recovery planning, and managing data availability policies and procedures); systems programmer (responsible for problem resolution, software installation, and system maintenance for mainframe and midrange systems); UNIX system administrator; capacity planner (monitoring business metrics, sales forecasts, computer system performance, directing tuning efforts, and planning upgrades for MVS, AS/400, NCR 3600, Teradata, UNISYS, and UNIX systems); and forensic software analyst.

Ms. Frederiksen was team leader for the storage management/capacity planning team of a fortune 100 company for over three years, responsible for software, robotic tape libraries, management policies, and automated processes used to backup and recover global enterprise computer systems. In this capacity she also developed

complex mathematical models to analyze and predict computer performance and capacity demands for national, regional, and global computer operations.

Since 1996 Ms. Frederiksen has worked in the field of computer forensics, first as a consultant to Johnson-Laird Inc. ("JLI"), of Portland, Oregon and now as the director of litigation services for its successor company, JurisLogic, LLC.

Ms. Frederiksen has performed forensic software analysis for a variety of clients in over 100 civil and criminal matters. These matters include forensic software analysis in the context of copyright, patent, and trade secret disputes. She has analyzed computer software and source code in the context of over 40 Copyright/Trade Secret disputes. Her analysis experience with respect to these matters includes the evaluation and comparison of computer source code and object code to detect copying and derivative works, identification of third party and open source materials, analysis of architectural and other non-literal similarities, and analysis of computer source code to determine whether it incorporates or makes use of specific trade secrets. Copyright and Trade Secret clients include companies such as Caterpillar, Computer Associates, Compuware, FOREX Capital Markets, LexisNexis, iGPS, ProvoCraft, Symantec, and Webtrends.

Ms. Frederiksen has also analyzed computer software, source code, or prior art in the context of over 35 patent disputes with respect to both infringement and validity analysis. Her analysis experience with respect to these matters includes analysis to determine how software functions and whether it practices the specific invention claimed in the patent(s) in suit. She is also experienced in the analysis of computer software that may constitute prior art for litigated patents and analysis of the development history of computer software with respect to on-sale bar issues. Patent clients include companies such as Active Video Networks, Connectix Corporation, Encyclopaedia Britannica, Grantley Patent Holdings, Herman Miller, Hyundai, In-Three, Microsoft, MPI Technologies, Pitney Bowes, Siemens-Rolm, Teknowledge Corporation, and University of Pittsburgh.

Ms. Frederiksen has over 50 years personal experience as a software developer and consultant, and is familiar with licensing and contract practices common in the software industry as they apply to software consulting agreements, custom development, software licensing, and the sale of computer software. In the course of her career she has been responsible for negotiating consulting agreements and custom software development agreements as both a consultant and as a consumer of those services. She has been responsible for negotiating software license agreements for a fortune 100 company and also personally as both a licensee and licensor in such agreements. She has also developed software products and negotiated contracts for their subsequent sale.

Ms. Frederiksen has specialized knowledge of the analysis and remediation of failed software development efforts. She has been involved in software system audits

performed by the State of Alaska, as well as forensic analysis relating to contractual disputes and litigation relating to failed software development efforts, licensing disputes, and the deployment and performance of software systems. As a forensic analyst, she has analyzed computer software, source code, and related computer-based evidence in the context of nine Software Licensing and Software Development disputes and three internal investigations relating to due-diligence for software acquisitions.

Ms. Frederiksen also has over five years experience with the oversight and evaluation of clean room procedures used for software development. This experience includes the development of clean room protocols and clean-room oversight, as well as actual experience programming in a clean room environment. In the context of her work for JLI and JurisLogic, Ms. Frederiksen has developed, reviewed, and critiqued clean room protocols; prepared educational presentations on clean room procedures and protocols for JLI clients; assisted with clean room set-up and oversight; and evaluated software that was developed using clean room protocols to determine whether it was free of inappropriate materials. She has also provided testimony at arbitrations and hearings in the United States and Canada relating to clean room development procedures and protocols.

Ms. Frederiksen has experience in the design, implementation, and ongoing administration of databases and multi-dimensional data aggregation systems used to support business analysis, performance reporting, cross-system data sharing, and ad-hoc decision support queries. She has specific experience with the design, programming, tuning, and administration of the hardware, software, and underlying database management systems implemented to support batch and on-line query and update systems, data warehouses, and data marts. She has developed and written application software used to allow users to manipulate and analyze data using pre-defined reports and ad-hoc queries as well as software used in the context of high-volume real time transaction and messaging systems. This experience includes special training from professional organizations such as CMG, and over ten years experience in the evaluation, modeling, and tuning of hardware and software systems' performance and capacity.

She is experienced in the recovery, preservation, and analysis of computer-based evidence. Ms. Frederiksen has assisted with discovery and analysis of computer software and computer-based evidence relating to large scale product liability investigations such as the Vioxx, Propulsid, Rezulin, and Ford/Firestone matters. She has also provided forensic analysis in civil and criminal investigations relating to unauthorized computer access, sabotage, internet trespass, spyware deployment, evidence tampering, and identity theft; as well as analysis performed in the context of internal software audits, acquisitions, and internal investigations relating to employee conduct.

Ms. Frederiksen has provided evidence recovery and analysis in criminal cases for the FBI and for the defense in *State of California v. Saghari*. She was a police reserve specialist with the Hillsboro Police department 2002-2009, assisting in criminal investigations involving computer-based evidence.

Papers and Presentations

- *"Digital Evidence – Digital Dilemmata"*, Tulane University Law School, New Orleans, Louisiana, March 15, 2023
- "*Prognostications on the Response of the Law to Technological Advances*" panel participant; Oregon State Bar Emerging Technologies-Charting the Future Course of the Law, Tigard, Oregon, October 12, 2018
- "*Cyber Liability from the Trenches: A Front Line Perspective*" (co-authored with Melissa Ventrone of Wilson Elser) Oregon State Bar Navigating the Pitfalls of an Online Business Presence-What Your Clients Need to Know, Tigard, Oregon, September 27, 2013
- "*Drones – A Culture of Fear*" District Of Oregon Conference Innovations in the Law: Science and Technology (joint effort of the US Court for the District of Oregon and the Oregon chapter of the Federal Bar Association), Portland, Oregon, September 20, 2013
- "*How Development Advances Put Security in Retreat*" NW ISSA Security Conference, Portland, Oregon, May 2, 2013
- *"Women in Computing"* Washington State University, Vancouver campus, Vancouver, Washington, March 28, 2011
- *"Open Source Issues in Mergers & Acquisitions"* (co-authored with Katherine C. Spelman, Esq.) Open Source & Security Cincinnati Intellectual Property Law Association (OSS3); Erlanger, Kentucky, October 27, 2011
- *"Reverse Engineering: Vulnerabilities and Solutions"* (co-authored with Susan Courtney) Pacific Northwest Software Quality Conference, Portland, Oregon, October 11, 2011
- *"Basic Computer Forensics (a lesson in modern Geek)"* Santa Clara Public Defenders' Office, San Jose, California, October 26, 2010
- *"Quality Pedigree Programs: Or How to Mitigate Risk and Cover Your Assets"* (co-authored with Marc Visnick and Susan Courtney) Pacific Northwest Software Quality Conference, Portland, Oregon, October 18, 2010
- *"Third Party Code Beware the Trojan Source!"* co-authored with Katherine C. Spelman, Esq., American Bar Association Section of Intellectual Property Law Landslide® Magazine, "in press"

- *"Finding the Snipers and Preserving the Evidence"* Oregon State Bar, Computer & Internet Law Section, Portland, Oregon, September 17, 2010
- *"Challenges in Corporate Forensics – Why Isn't Bigger Better?"* panel participant Digital Forensic Research Workshop (DFRWS), Portland, Oregon, August, 2010
- *"Beware of Geeks Bearing Gifts, Beware The Trojan Source!"* (co-authored with Kate Spelman, Esq.) University of Dayton School of Law: Significant Developments in the Intellectual Property Law of Computers and Cyberspace Conference, Dayton, Ohio, June 11, 2010
- *"Hack to the Future"* NW ISSA Security Conference, Portland, Oregon, May 6, 2010
- *"e-Discovery: Size Matters"* Oregon State Bar, Computer & Internet Law Section meeting, Portland, Oregon, February 23, 2010
- *"Software Pedigree Analysis: Trust But Verify"* (co-authored with Marc Visnick and Susan Courtney) Pacific Northwest Software Quality Conference, Portland, Oregon, October 28, 2009
- *"e-Discovery: Size Matters"* University of Dayton School of Law: Significant Developments in the Intellectual Property Law of Computers and Cyberspace Conference, Dayton, Ohio, June 12, 2009
- *"The Digital Detective: Looking for Evidence on Electronic Devices"* Portland State University, Mathematics Engineering Science Achievement (MESA) Conference, Portland, Oregon, April 11, 2009
- *"Computer Forensics in Civil Litigation"* Washington State University Vancouver, School of Engineering & Computer Science, Vancouver, Washington, April 7, 2009
- *"Discovering Electronic Evidence"* Tulane University Law School, New Orleans, Louisiana, March 18, 2009
- *"E-Discovery: A Survival Guide"* Tulane University Law School, New Orleans, Louisiana, March 16, 2009
- *"New Technology, New Challenges"* University of Dayton School of Law: Significant Developments In Computer & Cyberspace Law Convention, Dayton, Ohio, June 6, 2008
- "*Electronic Forensics - Today and Tomorrow*" Washington State University Vancouver, School of Engineering & Computer Science, Vancouver, Washington, April 1, 2008
- *Will Peer-to-Peer Disappear?* The Berglund Center for Internet Studies at Pacific University of Oregon, Forest Grove, Oregon, February 19, 2008

- *"Computer Forensics"* panel participant Portland Society for Information Management, Portland, Oregon, November 14, 2007
- *"Tuned In, Turned On, Spaced Out: How Technology is Changing Our Communities and Shaping Our Future"* panel participant Hillsboro Town Hall (Pacific Institute for Ethics and Social Policy), Hillsboro, Oregon, October 25, 2007
- *"Basic Computer Forensics (a lesson in modern Geek)*" Santa Clara Public Defenders' Office, San Jose, California, October 23, 2007
- *"Obtaining & Using Electronic Evidence"* panel participant 2007 National Employment Lawyers Association (NELA) Eighteenth Annual Convention, San Juan, Puerto Rico; June 27-30, 2007
- *"Where Are We Allowing Technology to Lead Us?"* University of Dayton School of Law Significant Developments In Computer & Cyberspace Law Convention, Dayton, Ohio, June 8, 2007
- "*Where Are We Allowing Technology to Lead Us*?" Computer Related Investigations, Management, and Education (CRIME), Hillsboro, Oregon, May 16, 2007
- *"Where Are We Allowing Technology to Lead Us?"* Keynote Address, International Technology Law Association Annual Meeting & World Conference, Chicago, IL; April 26-27, 2007
- *"The Law Firm's E-Data: A Risk Management Nightmare?"* panel participant 2007 Legal Malpractice & Risk Management Conference, Chicago, IL; March 6-9, 2007
- *"Computers and Disaster Planning: What Can We Learn from Katrina and SARS?"* Cutting Edge Issues in Technology Law, Seattle, WA, December 7-8, 2006
- *"Phishing, Pharming, & Wholesale Data Harvesting"* University of Dayton School of Law Significant Developments In Computer & Cyberspace Law Convention, Dayton, Ohio, June 9, 2006
- *"Lessons Learned From Katrina, SARS, and Other Disasters"* University of Dayton School of Law Significant Developments In Computer & Cyberspace Law Convention, Dayton, Ohio, June 9, 2006
- "*e-Discovery and the Proposed Federal Rules of Civil Procedure (FRCP) Changes - How Safe Is The Safe Harbo*r?" Cooley Godward LLP, San Diego, California, March 2, 2006
- "*Proposed Changes To Rule 26: A New Game?*", Oregon State Bar, Business Litigation Continuing Legal Education, Portland, Oregon, November 9, 2005

- "*A View from the Witness Stand,*" Computer Related Investigations, Management, and Education (CRIME), Portland, Oregon, September 7, 2005
- "*The Technology of Electronic Discovery*" Tulane Law School, New Orleans, Louisiana, April 20, 2004
- *"Preserving Documents and Data",* Association of Trial Lawyers of America, Case Management and Electronic Discovery in Pharmaceutical Litigation, Dallas, Texas, March 7–8, 2003
- *"Documents, Databases, Discovery and the Damned",* University of Kentucky College of Law 4th Annual Computer & Technology Law Institute, Lexington, Kentucky, November 1-2, 2002
- "*Forensic Software Analysis (electronic discovery)*", Louisiana State Bar Association – Mass Torts Symposium, New Orleans, Louisiana, October 25, 2002
- "*eDiscovery – The Role of an Expert*", Computer Related Investigations, Management, and Education (CRIME), Portland, Oregon, October 8, 2002
- *"Working with Experts"* (panel member), Computer Law Association, Orlando, Florida, October 3, 2002
- "*Efficient Discovery Through the Use of Technology*" Association of Trial Lawyers of America (ABTL), Atlanta, Georgia, July 20-24, 2002
- *"The Technology of Discovery Issues"* University of Dayton School of Law Advanced Computer and Cyberspace Law Convention, Dayton, Ohio, June 7, 2002
- "*Beyond Common Experience - Persuading the Jury with Expert Testimony Mini-Seminar*" panel participant and software expert, Association of Business Trial Lawyers (ABTL), San Diego, California, May 11, 2002
- *"Computer Searches and Seizures: Some Unresolved Issues,"* 8 Mich. Telecomm. Tech. L. Rev. 1 (2002), Susan W. Brenner and Barbara Frederiksen, available at http://www.mttlr.org/voleight/Brenner.html
- *"Information Technology Basics"* Sixth Annual CyberSpace Camp Conference, San Jose, California, February 14-16, 2002
- *"Emerging Issues in CyberSpace: Regulations without Borders and Borders without Regulations"* University of Calgary Faculty of Law, Alberta, Canada, February 6, 2002
- *"Evidence in the Age of Electrons*" Guest Lecturer, Professor Davis's Internet Litigation LLM course, Santa Clara University School of Law, Santa Clara, California, November 17, 2001

- *"Tunnel Blindness: Insecurity and the Internet"* Oregon State Bar Continuing Legal Education Computer Law in the New… new Economy, Portland, Oregon, November 2, 2001
- *"Forensic Software Analysis: Smoking Guns and Spinning Disks Redux"* Louisiana State Bar Class Action/Mass Torts Symposium 2001, New Orleans, Louisiana, October 26, 2001
- "*Beyond Common Experience - Persuading the Jury with Expert Testimony*" panel participant and software expert, Association of Business Trial Lawyers (ABTL), LaQuinta, California, October 12-14, 2001
- "*Tools and Techniques for Forensic Analysis*." 2001 Federal Public Defenders Computer Systems Administrator Conference, San Diego, California, June 12, 2001
- *"Technologies for Data Collection and Snooping."* University of Dayton School of Law Computer and Cyberspace Law Convention, Dayton, Ohio, June 8, 2001
- "*New Technologies and the Legal Issues They Raise*." University of Dayton School of Law Computer and Cyberspace Law Convention, Dayton, Ohio, June 8, 2001
- "*Records Retention, Privacy, and the Age of Electrons*." Financial Women's Association, Silicon Valley Conference, San Francisco, California, March 2001
- "*Managing The Mountain -- Strategies For Computer Based Evidence*." Clifford Chance, In-house conference, London, England, March 2001
- "Managing The Mountain -- Strategies For Computer Based Evidence." The Computer Law Association European CyberSpaceCamp Conference, Amsterdam, the Netherlands, March, 2001
- "What You Need to Know About Domain Names: Introduction and Overview." Domain Name Protection, Litigation & Management Summit, San Francisco, California, February 2001
- "Computer Based Evidence: Strategies To Manage The Mountain" Herman Middleton, New Orleans, January 2001
- ALI-ABA Trial Of A Software Patent Case: Panel participant and software expert presenting video taped testimony for the mock trial. Chicago, Illinois, September 2000
- *"The ABCs of CBE (Computer-Based Evidence)."* Oregon Criminal Defense Lawyers Association, Bend, Oregon, June 2000
- *"New Technologies: New Challenges for the Law"* (Paper co-authored with Andy Johnson-Laird, William R. Trost), Dayton Law Journal, June, 2000

- *"Computers and the Law: Collaboration or Collision?"* (Paper co-authored with Andy Johnson-Laird, William R. Trost), The Second Annual Symposium On Information Technology And Cyberspace Law, May, 2000 (Osgoode Hall Law School of York University, Toronto, Canada)
- "Electronic Evidence (Too Much of A Good Thing?)" Santa Clara County Bar Association, May, 2000 (CLE)
- "Bringing Your Story Home: Technology In The Courtroom" Willamette University College Of Law, May 2000
- *"Computer Based Evidence – The ABCs of CBE"* Willamette University College of Law, April, 2000
- "*Making Sense of Electronic Evidence*" Conference For Federal Defender Administrators And Computer Systems Administrators, April, 2000
- FJC Mini Conference on Discovery of Computerized Information, Hastings College Of Law, March, 2000
- "*Techno-Archeology™ - The Analysis of Failed Software Development*" Lane Powell Spears Lubersky, November, 1999 (CLE)
- *"Y2K Incoming! – Preserving Evidence For The Inevitable"* Oregon State Bar, Computer Law Section, November, 1999 (CLE)
- *"The Preservation and Analysis of Computer-based Evidence,"* Powell, Goldstein, Frazer & Murphy, August, 1999 (CLE)
- *"Forensic Software Analysis: Preservation Discovery and Analysis of Computer-based Evidence,"* Computer Related Investigations, Management, and Education (CRIME), April 13, 1999
- *"Forensic Software Analysis: The Preservation and Analysis of Computer-based Evidence,"* Miller, Nash, Wiener, Hager & Carlsen, February, 1999
- "*A Silent Chorus – The Relevance of Electronic Evidence,*" Willamette University College of Law, Internet Law Caucus, November 1998

Expert Testimony

Court Appointed Expert

1. Court Data System Advisor to the Honorable Marvin J. Garbis, in the U.S. District Court for the District of Maryland, in the matter of Vaughn G., et al. v. Walter G. Amprey, et al., Civil Action No. MJG-84-1911.

2. Neutral expert for the Court on issues relating to data search and recovery in the U.S. District Court for the District of Oregon in the matter of Solar Nation, Inc. v. Solar Jones, Inc., et al., Case No. 3:12-CV-01199-BR

Trial Testimony

1. Admitted as an expert in computer science, computer technology, forensic examination, and source code in the U.S. District Court for the District of Nevada, *Oracle International Corporation v. Rimini Street, Inc.*; Case No. 2:14-cv-1699-MMD-DJA November 2022 (Engaged by plaintiff)
2. Admitted as an expert in computer and software forensics in the U.S. District Court for the Western District of Texas Austin Division, *UMG Recordings, Inc., et al v. Grande Communications Networks LLC and Patriot Media Consulting, LLC*; Case No. 1:18-mc-00613-LY October 2022 (Engaged by plaintiffs)
3. Admitted as a technical expert in the US District Court, District of Nevada, *Oracle USA, Inc., et al v. Rimini Street Inc*; Case No. 2:10-cv-0106-LRH-VCF September 2021 (Engaged by plaintiff – bench trial offer to show cause)
4. Admitted as an expert in computer programming, software development and forensics analysis in computer and software in the US District Court for the Northern District of Illinois Eastern Division, *Motorola Solutions, Inc., et al. v. Hytera Communications Corporation Ltd. et al.*; Case No. 1:17-cv-01973 (Engaged by defendants)
5. Admitted as an expert in the analysis of computer software and computer-generated data in the US District Court for the Eastern District of Virginia, *Sony Music Entertainment, et al. v. Cox Communications, Inc., et al.;* Case No. 1:18-cv-00950-LO-JFA; December 2019 (Engaged by plaintiffs)
6. Admitted as an expert in forensic software analysis, software design, and reverse engineering in the US District Court for the Eastern District of New York, *Point 4 Data Corporation and Dynamic Concepts Inc. v. Tri-State Surgical Supply & Equipment Ltd., SJ Computers, Inc. and Shmuel Judkovitz*; Case No. 11-cv-0726 (RJD); August 2018 (Engaged by plaintiffs for software analysis).
7. Admitted as an expert in the areas of computer forensics and source code analysis in the US District Court for the Northern District of Texas Dallas Division, *Zenimax Media Inc. and ID Software LLC v. Oculus VR, LLC, Palmer Luckey, and Facebook, Inc.,* Case No. 3:14-cv-1849-K; January 2017 (Engaged by Oculus (defendant) for software analysis in the context of a copyright suit).
8. Admitted as an expert in the areas of forensic software analysis and software design, development and programming in the US District Court for the District of Puerto Rico, *Puerto Rico Treasury Department v. OPG Technology*

Corp., et al., Case No. 3:15-cv-03125 (JAG) August 2016 (Engaged by OPG Technology Corp (defendant) for software analysis in the context of a copyright suit).

9. Admitted as an expert in computer programming and computer forensics in the US District Court for the Eastern District of Virginia, *BMG Rights Management (US) LLC, and Round Hill Music LP v. Cox Enterprises, Inc., Cox Communications, Inc., Coxcom, LLC*, Case No. 1:14-cv-1611 (LOG/JFA) December 2015 (Engaged by BMG Rights Management (plaintiff) for source code related analysis in the context of a copyright suit.)
10. Admitted as an expert in software investigation in the US District Court for the Northern District of California San Francisco Division, *Fujifilm Corporation v. Motorola Mobility LLC*, Case No. C12-03587 RS; April 2015 (Engaged by Fujifilm (plaintiff) Corporation for source code analysis related to accused software in the context of a patent infringement suit)
11. Admitted as an expert in computer science, source code, and software development in the US District Court for the District of Delaware, *Finjan, Inc v. Symantec Corp., Webroot Software, Inc. Websense, Inc. and Sophos, Inc.,* Civil Action No. 10-593-GMS; December 2013. (Engaged by Websense, Inc. for source code analysis related to accused software in the context of a patent infringement suit.)
12. Admitted as an expert to provide testimony about video data in the District Court of Bexar County, Texas, 407th Judicial District, *Karen D. Griffin, individually and Virginia L. Brunner, as next of friend of Karen D. Griffin v. Union Pacific Railroad Company, Kenneth Piper and Gary Anderson*, Cause No. 2010-CI08523; March 2012 (Engaged by the plaintiff, discovery issues and analysis relating to analysis of electronic Track Image Recorder Video files.)
13. Admitted as an expert in computer software in the US District Court for the Eastern District of Virginia, Norfolk Division**,** *ActiveVideo Networks, Inc. v. Verizon Communications, Inc. Verizon Services Corp., Verizon Virginia, Inc. and Verizon South, Inc.***,** Civil Action No. 2:10-cv-248; July 2011. (Engaged by ActiveVideo Networks for source code analysis related to accused devices in the context of a patent infringement suit.)
14. Admitted as an expert in software engineering in the U.S. District Court for the Eastern District of Texas, Tyler Division, *Clear With Computers, LLC. v. Hyundai Motor America, Inc.*, Case No. 6:09-cv-479 LED; June 2011. (Engaged by Hyundai Motor America, Inc. for invalidity analysis in the context of a patent infringement suit.)
15. Admitted as an expert in computer based evidence in *The People of the State of California v. Jason Cai,* Superior Court of the State of California, for the

County of Santa Clara, Case No. CC810427; July 2010. (Engaged by counsel for defendant in a homicide matter)

16. *Bill Fraser, Soo Min Fay, Doug Frosch, George Marshall, Cal Mitchell, Jim Rubino, Tim Shea, John Sullivan, and Steve Munson v. Valley Energy Investment Fund U.S., L.P., Vulcan Investment Holdings, LLC, Denham Commodity Partners Fund V LP, Denham Capital Management L.P., Merrill Lynch Commodity Partners, LLC, Scott Mackin, David Owens, Rod Wimer, Robert Warburton, Todd Bright, Robert Jones, and Vulcan Power Company,* Circuit Court for the State of Oregon, Lane County, Case No. 160826841; June 2010. (Engaged by Plaintiffs to assess whether discovery costs incurred by Defendants were reasonable in the context of case fact pattern.)
17. Admitted as expert in evidentiary hearing In the Circuit Court of the 11th Judicial Circuit, In and For Miami-Dade County, Florida, General Jurisdiction Division, *Jarrell Cannon a minor by and through his mother and natural guardian, Alicia Lott, and Alicia Lott, individually v. Ford Motor Company, and Hazel Edgecomb*, Case No. 05-21648 CA20; May 2009 (Engaged by plaintiffs in the context of technical issues in discovery)
18. Admitted as an expert in the District Court of Tarrant County, Texas, discovery hearing, *Estate of Dwayne Freeto, et al. v. Ford Motor Company and Scott Hilburn*, Case No. 348-233429-08; March 2010. (Engaged by the Estate of Dwayne Freeto, et al., discovery issues and analysis relating to electronic data.)
19. *CollegeNet, Inc. v. XAP Corporation*, U.S. District Court for the District of Oregon, Case No. 03-1229-BR; June 2008 (Engaged by XAP Corporation, analysis of inequitable conduct during patent prosecution.)
20. Admitted as an expert on software analysis in *Grantley Patent Holdings, Ltd. v. Clear Channel Communications, Inc., et al.*, Case No. 9:06cv259; April, 2008 (Engaged by Grantley Patent Holdings, Ltd., patent infringement/validity.)
21. Markman hearing in *Grantley Patent Holdings, Ltd. v. Clear Channel Communications, Inc., et al.*, Case No. 9:06cv259; October 2007 (Engaged by Grantley Patent Holdings, Ltd.)
22. Admitted as a software expert in *Ricoh Corporation and Ricoh Company, Ltd. v. Pitney Bowes, Inc.*, Case No. 02-5639 (GEB); November 2006 (Engaged by Pitney Bowes Inc., patent infringement/validity.)
23. Admitted as an expert on software analysis *CollegeNet, Inc. v. XAP Corporation*, U.S. District Court for the District of Oregon, Case No. 03-1229-BR; September 2006 (Engaged by XAP Corporation, patent infringement/validity.)

24. Admitted as an expert on computer software development, clean room procedures, and database in *HotSamba, Inc. v. Caterpillar, Inc.*, U.S. District Court Northern District of Illinois Eastern Division, Case No. 01-C-5540, September 2006 (Engaged by Caterpillar Inc., copyright/licensing dispute/breach of contract.)

25. Admitted as an expert on software development and the recover and analysis of computer based evidence in *Compuware Corporation v. International Business Machines Corp.*, United States District Court for the Eastern District of Michigan, Case No. 02-70906, March, 2005 (Engaged by Compuware Corporation to perform analysis of computer based evidence relating to copyright/trade secret issues.)

26. Admitted as an expert on the analysis of computer based evidence in *Norman B. Feaster et al. v. CSX Transportation, Inc.*, Franklin County Circuit Court Case No. 10,913-CV, November 2002 (Engaged by Norman B. Feaster, et al, railroad case involving analysis of locomotive event recorder data.)

27. Admitted as an expert on recovery and analysis of computer based evidence in *Bridgestone/Firestone, Inc., ATX, ATX II, and Wilderness Tires, Products Liability Litigation*, United States District Court Southern District of Indiana Indianapolis Division Court Case No. IP00-9373-C-B/S MDL No. 1373, February 2002 (Engaged by Plaintiffs' Litigation Committee, discovery issues and analysis relating to electronic data.)

28. Admitted as an expert on computer software and the analysis of computer based evidence in *United States of America v. Santee Sioux Tribe of Nebraska,* United States District Court for the District of Nebraska, Case No. 8:96CV367, October, 2001 (Engaged by Santee Sioux Tribe of Nebraska, analysis relating to the software used for operation of computer controlled gaming devices.)

29. Admitted as an expert on recovery and analysis of computer based evidence in *Tim O'Neil v. Levi Strauss and Company et al,* Superior Court of California, Case No. 221466, February, 2001 (Engaged by Levi Strauss and Company, recover and analyze computer based evidence.)

30. Admitted as an expert on recovery and analysis of computer based evidence in *State of California v. Bahram Saghari,* Superior Court of California, Case No. 205525, February, 2000. (Engaged by Bahram Saghari, recover and analyze computer source code and computer based evidence)

31. Admitted as an expert on computer software development in *Novinger v. TRW et al.*, U.S. District Court for the District of Oregon, Case No. CV96-286-JE, July, 1998. (Engaged by Novinger, to review software and data management practices relating to an identity theft case)

Other Court (State and Federal) Testimony

1. Hearing in the US District Court Middle District of Florida Tampa Division; *UMG Recordings, Inc., et al v. Bright House Networks, LLC*, Case No. 8:19-cv-710-MSS-TGW; May 25, 2022

Arbitration Testimony

1. Judicial Arbitration and Mediation Services, Inc. (JAMS), *Chrome Systems, Inc. v. Autodata Solutions, Inc., et al*. (Case No. 11808-VCG), JAMS Reference No. 1340012931; September 2016 (Engaged by Autodata Solutions (defendant) for copyright dispute)
2. *In the Matter of the Companies' Creditors Arrangement Act, R.S.C. 1985, c.C.36, as Amended And in the Matter of a Plan or Arrangement of Nortel Networks Corporation, Nortel Networks Limited, Nortel Networks Global Corporation and Nortel Networks Technology Corporation*, (discovery hearing ordered by) Ontario Superior Court of Justice, Court File No. 09-CL-7950 (Engaged by SNMP Research International and SNMP Research, Inc. for analysis of technical materials and discovery issues)
3. Judicial Arbitration and Mediation Services, Inc. (JAMS), *The Clearing Corporation v. The Chicago Merchantile Exchange, Inc.*, Case No. 06CH10553, April 2008 (Engaged by The Clearing Corporation relating to breach of license/copyright dispute.)
4. Judicial Arbitration and Mediation Services, Inc. (JAMS), *Polimaster Ltd and NA&SE Trading Co., Limited and RAE Systems, Inc.*, Case No. 1110009296, March 2007 (Engaged by RAE Systems, Inc. to analyze software relating to copyright, trade secret, and reverse engineering allegations.)
5. International Commercial Arbitration Act, *MPI Technologies, Inc., and Xerox Canada, Ltd and Xerox Corporation*, January 2005 (Engaged by MPI Technologies to analyze computer software and evidence relating to a breach of license/copyright dispute.)
6. American Arbitration Association, *Bionic Buffalo Corporation v. Integrated Systems, Inc. and WindRiver Systems, Inc.*, Case No. 79 117 0011299, February 2002. (Engaged by Integrated Systems, Inc. to analyze computer software and evidence relating to a breach of contract/copyright dispute.)
7. American Arbitration Association, *Rollins, Inc., v. ALE Systems,* Case No. AAA30 181 00081 98, June, 1999 and August 1999. (Engaged by Rollins, Inc., to analyze computer software and evidence relating to a breach of contract/failed software development dispute.)

Deposition Testimony

1. US Bankruptcy Court Southern District of New York; *In re Frontier Communications Corporation, et al.*; Case No. 20-22476 (MG); January 2025
2. US District Court Northern District of California; *Scientific Applications & Research Associates (SARA), Inc. v. Zipline International, Inc.*; Case No. 3:22-cv-04480-JSC; November 2024
3. US District Court District of Connecticut; *Post University, Inc. v. Course Hero, Inc.*; Case No. 3:21-cv-01242; May 2024
4. US District Court for the District of Delaware; *Design With Friends, Inc. and Design With Friends Ltd. v. Target Corporation*; Case No. 1:21:-cv-01376-SB; January 2024
5. US District Court for the District of Delaware; *Thomson Reuters Enterprise Centre GMBH and West Publishing Corporation v. Ross Intelligence, Inc.*; Case No. 20-613-LPS; November 2022
6. US District Court for the Southern District of Florida Miami Division; *Athos Overseas, Ltd. v. YouTube, Inc., YouTube, LLC, and Google, LLC;* Case No. 1:21-cv-21698-DPG; October 2022
7. US District Court for the Southern District of California; *MedImpact Healthcare Systems, Inc., et al v. IQVIA Inc., et al*; Case No. 3:19-cv-01865-GPC-LL; February 2022
8. US District Court for the Western District of Texas, Austin Division; *UMG Recordings, Inc., et al v. Grande Communications Networks LLC and Patriot Media Consulting, LLC*; Case No. 1:17-CV-365; December 2021
9. US District Court Middle District of Florida, Tampa Division; *UMG Recordings, Inc., et al v. Bright House Networks, LLC*; Case No. 8:19-cv-710-MSS-TGW; November 2021
10. US District Court for the District of Colorado; *Warner Records Inc., et al. v. Charter Communications, Inc.*; Case No. 19-cv-00874-RBJ-MEH; October 2021
11. US District Court for the Western District of Texas Austin Division; *Via Vadis, LLC and AC Technologies, S.A. v. Blizzard Entertainment, Inc.*; Case No. 1:14-cv-810-LY; July 2021
12. US District Court Southern District of New York; In Re Keurig Green Mountain Single Serve Coffee Antitrust Litigation *JBR, Inc. (dba Rogers Family Company) v. Keurig Green Mountain, Inc. (fka Green Mountain Coffee Roasters, Inc., and as successor to Keurig, Inc.)*; ECF case 1:14-md-2542-VSB-HBP (MDL No. 2542); March 2021

13. Superior Court of the State of California County of San Francisco; *Qorum, Inc. v. QAProsoft, LLC; Solvd, Inc., Igor Lysenko, Igor Vayner, and Does 1 through 50, inclusive*; Case No. CGC-19-577985; January 2021
14. US District Court for the Eastern District of Michigan Southern Division; *Bruce Zak v. Facebook, Inc.*; Case No. 4:15-cv-13437-TGB-MJH; December 2020
15. US District Court for the District of Nevada; *Oracle USA Inc., Oracle America, Inc., and Oracle International Corporation v. Rimini Street, Inc., and Seth Ravin*; Case No. 2:10-cv-0106 LRH-VCF; June 2020
16. American Arbitration Association; *Press Ganey Associates, Inc. v. Qualtrics, Inc.*; Case No. 01-18-0004-4674; October 2019
17. US District Court for the Northern District of Illinois, Eastern Division; *Motorola Solutions, Inc., et al v. Hytera Communications Corporation Ltd., et al*; Case No. 1:17-CV-01973; September 2019
18. US District Court for the Eastern District of Virginia; *Sony Music Entertainment, et al v. Cox Communications Inc. and CoxCom LLC*; Case No. 1:18-cv-00950-LO-JFA; June 2019
19. US District Court for the Western District of Texas, Austin Division; *UMG Recordings, Inc., et al. v. Grande Communications Networks LLC and Patriot Media Consulting, LLC*; Case No. 1:17-cv-00365; October 2018
20. US District Court District of Nevada, *Rimini Street, Inc. v. Oracle International Corporation; Oracle America Inc., Oracle International Corporation v. Rimini Street, Inc., Seth Ravin*; Case No. 2:14-cv-01699-LDG-VCF; September 2018
21. US District Court Northern District of California, *Foresee Results, Inc., Answers Corporation v. Auryc, Inc., Auryc LLC, Jinlin Wang, Feng Shao, Amod Setlur and Does 1 through 20*; Case No. 3:17-cv-06973-RS; September 2018
22. U.S. District Court Southern District of New York, *RELX, Inc. v. Informatica Corp*; Case No. 1:16-cv-9718-AKH; June 2018
23. In the Circuit Court of the 17th Judicial Circuit in and for Broward County, Florida, Complex Business Division, *Flexible Business Systems, Inc. v. Seacor Island Lines LLC and Seacor Holdings Inc.*; Case No. 15-006350 CACE (07); February 2018
24. US Bankruptcy Court for the District of Delaware, *In re Nortel Networks, Inc.*, Bankr Case No. 09-10138(KG); *SNMP Research International, Inc., and SNMP Research, Inc. vs. Nortel Networks, Inc., et al. and Avaya, Inc.*; Case Adv Proc. No. 11-53454(KG); February 2017
25. US District Court for the District of Delaware, *Avaya, Inc. v. SNMP Research Inc.*, Case No. 12-191-RGA; January 2016

26. US District Court for the Southern District of California, *Anthony Johnson v. Storix, Inc.*, Case No. 14-CV-1873-H-BLM; October 2015
27. US District Court for the Eastern District of Virginia, *BMG Rights Management(US) LLC, and Round Hill Music LP v. Cox Enterprises, Inc., Cox Communications, Inc., CoxCom, LLC*, Case No. 1:14-cv-1611(LOG/JFA); August 2015
28. US District Court for the Northern District of California San Francisco Division, *Fujifilm Corporation v. Motorola Mobility LLC*, Case No. C12-03587 RS; November 2014
29. US District Court for the Eastern District of New York; *Point 4 Data Corporation and Dynamic Concepts, Inc. v. Tri-State Surgical Supply & Equipment, Ltd., SJ Computers, Inc., and Shmuel Judkovitz*, Case No. 11 CV 0726 (RJD); June 2012
30. US District Court for the District of Delaware; Finjan, Inc. v. McAfee, Inc., Symantec Corp., Webroot Software, Inc., Websense Inc., and Sophos, Inc., Case No. 10-593-GMS; June 2012 (Engaged by defendant Websense Inc.; patent infringement)
31. US District Court for the Eastern District of Louisiana; *Sean Bowie v. The New Orleans Public Belt Railroad Commission, d/b/a New Orleans Public Belt Railroad Company*, Case No. 11-00755; June 2012
32. US District Court for the Central District of California, Southern Division; *Bryan Pringle v. William Adams, Jr., et al.*, Case No. SACV10-1656 JST (RZx); January 2012 (Engaged by plaintiff to address issues related to spoliation and copyright infringement allegations)
33. In the District Court of Bexar County, Texas, 407th Judicial District; *Karen Griffin v. Union Pacific Railroad Company*, et al., Cause No. 2010-CI08523; December 2011 (Engaged by plaintiffs in the context of a railroad case requiring analysis of TIR (Track Image Recorder) video)
34. US District Court for the Western District of Pennsylvania, *University of Pittsburgh of the Commonwealth System of Higher Education dba University of Pittsburgh v. Varian Medical Systems, Inc.*; Case No. 2:08-cv-01307, September 2011 (Engaged by University of Pittsburgh; patent infringement)
35. US District Court for the Eastern District of Virginia, Norfolk Division, *ActiveVideo Networks, Inc. v. Verizon Communications, Inc., Verizon Services Corp., Verizon Virginia, Inc., and Verizon South Inc.*; Case No. 2:10-cv-248-RAJ-FBS, June 2011 (Engaged by ActiveVideo Networks, Inc. ; patent infringement)

36. U.S. District Court for the Eastern District of Texas, Tyler Division, *Clear With Computers, LLC. v. Hyundai Motor America, Inc.*, Case No. 6:09-cv-479 LED, April 2011 (Engaged by Hyundai Motor America, Inc.; patent infringement suit.)
37. In the Circuit Court of the 11th Judicial Circuit, In and For Miami-Dade County, Florida, General Jurisdiction Division, *Jarrell Cannon a minor by and through his mother and natural guardian, Alicia Lott, and Alicia Lott, individually v. Ford Motor Company, and Hazel Edgecomb*, Case No. 05-21648 CA20, March 2011 (Engaged by plaintiffs in the context of technical issues in discovery)
38. U.S. District Court for the Eastern District of Texas, Tyler Division, *Clear With Computers, LLC. v. Hyundai Motor America, Inc.*, Case No. 6:09-cv-479 LED, March 2011 (Engaged by Hyundai Motor America, Inc. patent infringement suit.)
39. In the Circuit Court of Cook County, Illinois, County Department-Chancery Division, *Citadel Investment Group, v. Teza Technologies, LLC, et al.*, Case No. 09 CH 22478, July 2010. (Engaged by Teza Technologies to verify effectiveness of clean room protocol.)
40. U.S. District Court for the District of Oregon, *CollegeNet, Inc. v. XAP Corporation*, Case No. 03-1229-BR, April 2008. (Engaged by XAP Corporation, to analyze computer software in the context of a patent infringement suit.)
41. U.S. District Court for the Western District of Wisconsin, *Extreme Networks, Inc. v. Enterasys, Inc.*, Case No. 07-C-0229-C, February 2008. (Engaged by Enterasys, Inc., patent infringement.)
42. U.S. District Court for the Eastern District of Texas, Lufkin Division, *Grantley Patent Holdings, Ltd. v. Clear Channel Communications, Inc.*, et al; Case No. 9:06cv259, February 2008 (Engaged by Grantley Patent Holdings, Ltd., patent infringement.)
43. U.S. District Court for the Western District of Wisconsin, *Extreme Networks, Inc. v. Enterasys, Inc.*, Case No. 07-C-0229-C, January 2008. (Engaged by Enterasys, Inc., patent infringement.)
44. U.S. District Court Northern District of California San Jose Division, *Creative Science Systems, Inc. v. Forex Capital Markets LLC and REFCO Group Ltd., LLC*, Case No. C04-03746 JF (RS), September 2006. (Engaged by Forex Capital Markets to perform analysis in the context of a software licensing dispute.)
45. U.S. District Court Northern District of Minnesota, *Ricoh Corporation and Ricoh Company, Ltd. v. Pitney Bowes, Inc.*, Case No. 02-5639 (GEB), August 2006. (Engaged by Pitney Bowes Inc., patent infringement.)

46. U.S. District Court Northern District of Illinois Eastern Division, *HotSamba, Inc. v. Caterpillar, Inc.*, Case No. 01-C-5540, July 2006. (Engaged by Caterpillar Inc.)
47. U.S. District Court for the District of Oregon, *CollegeNet, Inc. v. XAP Corporation*, Case No. 03-1229-BR, March 2006. (Engaged by XAP Corporation, to analyze computer software in the context of a patent infringement suit.)
48. U.S. District Court Northern District of California San Jose Division, *Creative Science Systems, Inc. v. Forex Capital Markets LLC and REFCO Group Ltd., LLC*, Case No. C04-03746 JF (RS), March 2006. (Engaged by Forex Capital Markets to perform analysis in the context of a software licensing/copyright dispute.)
49. U.S. District Court Central District of California Western Division, *Imax Corporation and Three-Dimensional Media Group, Ltd. V. In-Three, Inc.*, Case No. CV-05-1795 (Mcx), August 2005. (Engaged by In-Three, Inc., to perform analysis of computer software relating to patent validity and prior art.)
50. Superior Court of the State of California, County of San Diego, *Del Mar Datatrac, Inc. v. ProLender Solutions, Inc., et al.,* Case No. GIC 817717, June 2004 (Engaged by Del Mar Datatrac, to analyze computer software in the context of a trade secret/copyright case and oversight of subsequent software production to verify effectiveness of clean room procedures used during remediation.)
51. U.S. District Court Northern District of California Oakland Division, *Compuware Corporation v. International Business Machines*, Case No. 02-70906, May 2003, June 2003, June 2004, and January 2005. (Engaged by Compuware Corporation to perform analysis of computer software and software development efforts in the context of a copyright/trade secret dispute.)
52. U.S. District Court Northern District of California Oakland Division, *VMware, Inc. v. Connectix Corporation and Microsoft Corporation*, Case C03 00654 CW, April 2003. (Engaged by Connectix Corporation, to perform analysis of computer software and potential prior art in the context of a patent dispute.)
53. U.S. District Court for the Eastern District of Virginia, Alexandria Division, *Washington Post. Newsweek Interactive Company, LLC., et al v. The Gator Corporation*, Case No. 02-909-A, December 2002. (Engaged by The Gator Corporation for analysis of computer software and computer-based evidence relating to a dispute involving pop-up advertisements.)
54. Franklin County Circuit Court, *Norman B. Feaster et al. v. CSX Transportation, Inc., et al.*, Franklin County Circuit Court Case No. 10,913-CV, November 2002. (Engaged by Norman B. Feaster, et al. in the context of a railroad case requiring analysis of locomotive event recorder data.)

55. The Superior Court Of The State Of California, *Tim O'Neil v. Levi Strauss and Company, Earnest "Hap" Wheale, Katy Basile, Ruth Meyler, and DOES 1 through 100*, Case No. 305531, January 2001. (Engaged by Levi Strauss and Company, recover and analyze computer based evidence.)
56. U.S. District Court for the Northern District of Illinois, Eastern Division, *Chris-Craft Industrial Products, Inc. v. Kuraray Company, Ltd., Kuraray America, Inc. Cast Film Technology, Inc. and James R. Rossman*, Case No. 98 CV 7298. (Engaged by Chris-Craft to recover and analyze data related to trade secret misappropriation.)
57. U.S. District Court for the District of Oregon, *Novinger v. TRW,* Case No. CV96-286-JE. (Engaged by Novinger, to analyze computer software and data management practices relating to an identity theft case.)